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WING LABORATORIES INC.

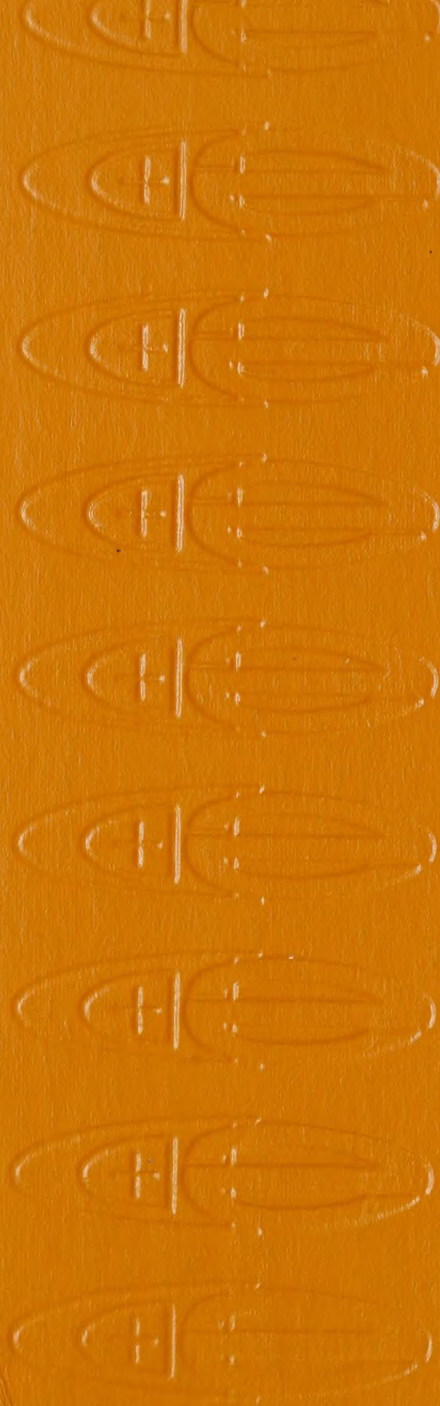


CAUTION CONTROL  
3298 0/6



SYSTRON  DONNER





ADDENDUM  
MODEL 6150

The Model 6150 Counter/Timer is identical to the Model 6153-50 described in this manual with only the following exceptions:

1. The D INPUT Type N connector has been removed and the RATE D FUNCTION switch position omitted.
2. The A20, A14, and A15 assemblies have been removed.
3. The A12 and A16 assemblies have been replaced.
4. The 10 nS range is omitted unless Option 42 has been added to the unit.
5. Drawings included:

|                                     |           |
|-------------------------------------|-----------|
| Block Diagram, Model 6150           | #E45169   |
| A12 50 MHz Decade & Gate Assembly   | #C39812   |
| A12 50 MHz Decade & Gate Schematic  | #D39809   |
| A12 50 MHz Decade & Gate Parts List | #P/L39812 |
|                                     |           |
| A16 50 MHz Amplifier Assembly       | #B39718   |
| A16 50 MHz Amplifier Schematic      | #C39715   |
| A16 50 MHz Amplifier Parts List     | #P/L39718 |

CONCORD INSTRUMENT  
DIVISION

MODEL 6150

COUNTER/TIMER

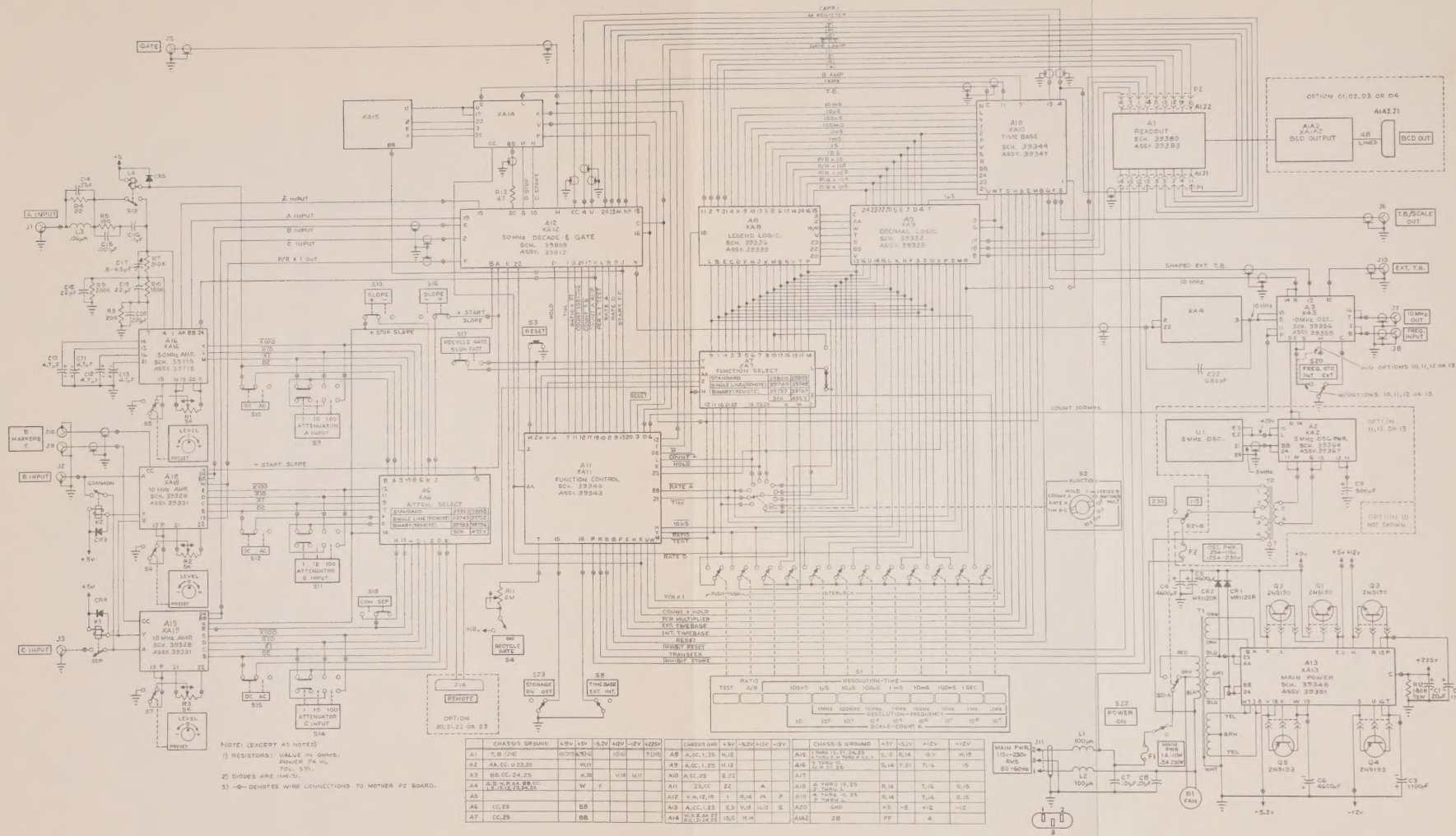




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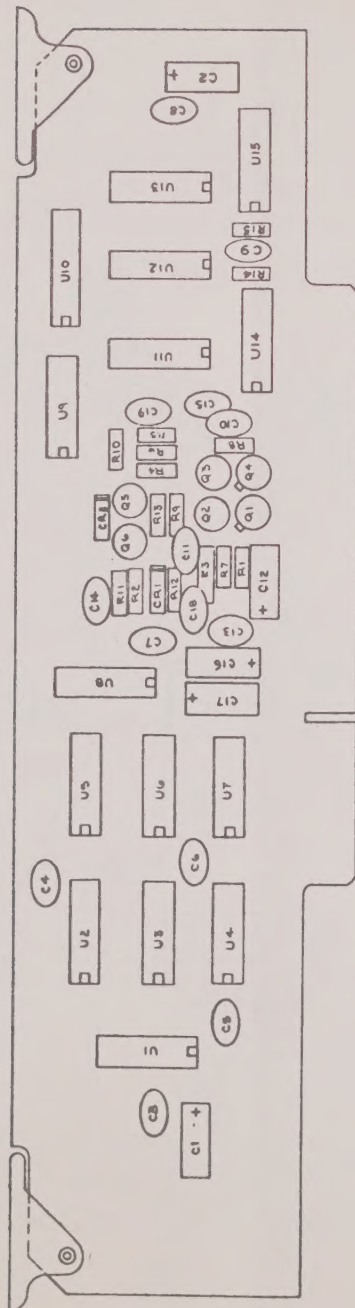
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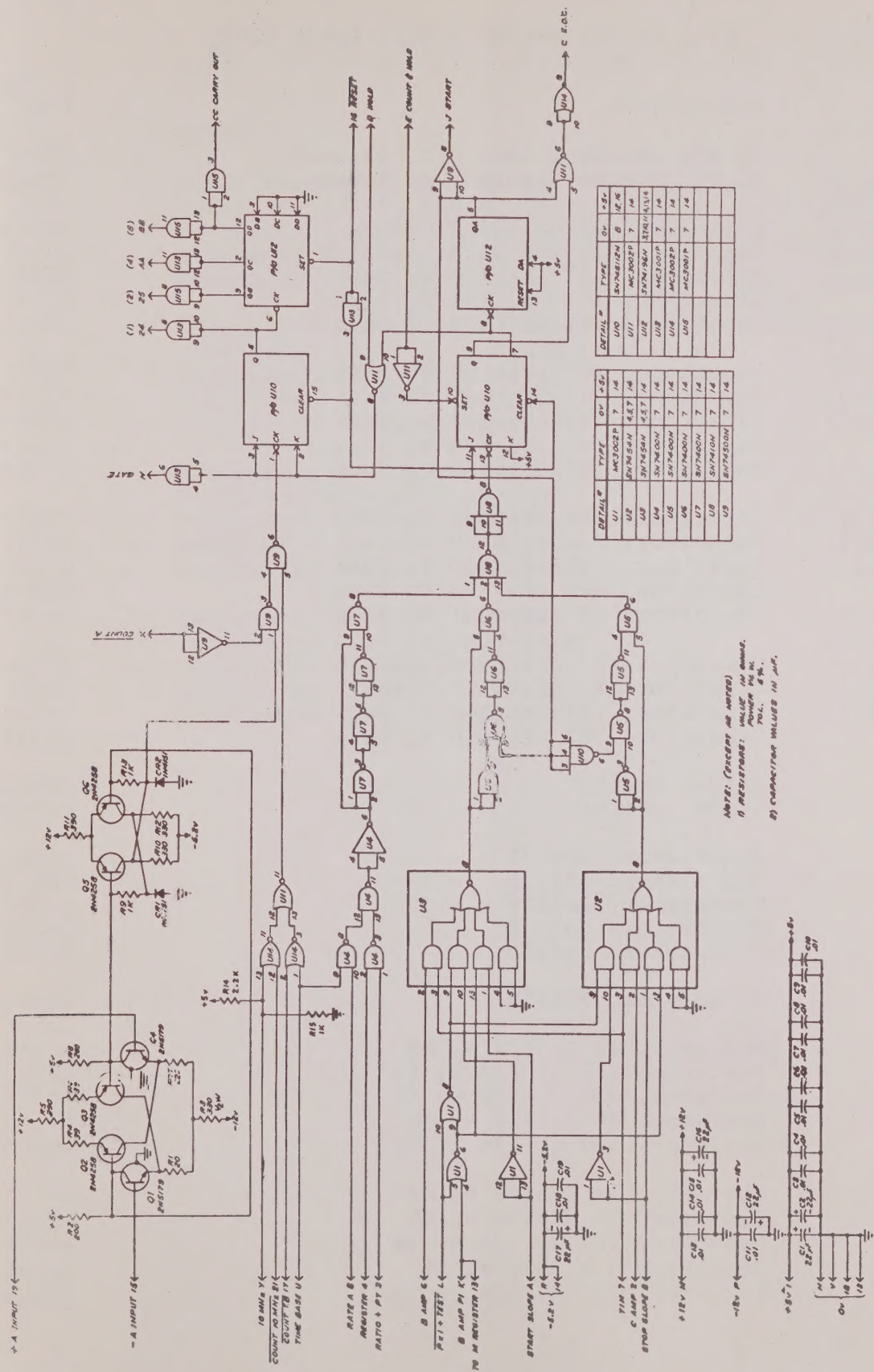
MODEL 6150  
 BLOCK DIAGRAM #E45169B





A12, 50 MHz DECADE & GATE P.C. ASSEMBLY #C39812B





A12, 50 MHz DECADE &amp; GATE SCHEMATIC #D39809C

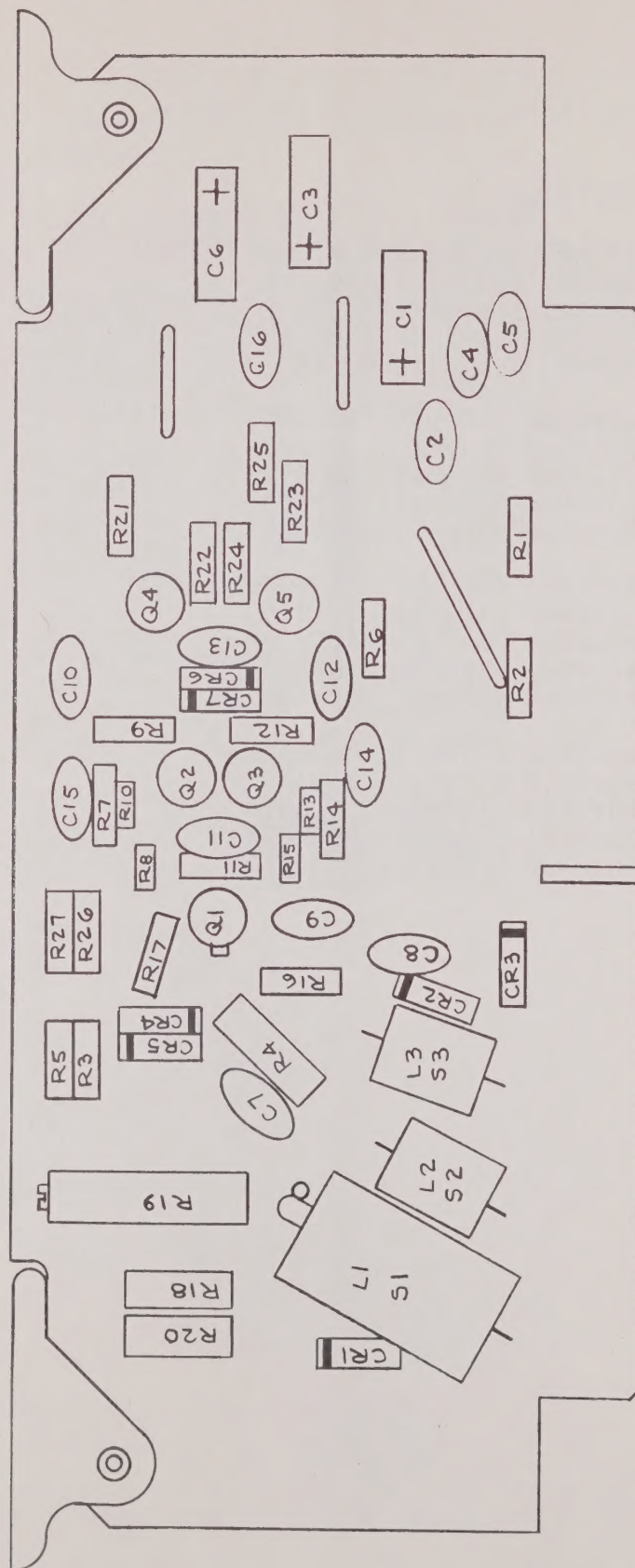
# A12, 50 MHz DECADE & GATE PARTS LIST

| REF. | DESCRIPTION                         | SD<br>PART NO. |
|------|-------------------------------------|----------------|
|      | 50 MHz Decade & Gate P.C. Assembly  | C39812         |
|      | 50 MHz Decade & Gate P.C. Schematic | D39809         |
| C1   | Capacitor, 22 $\mu$ F, 25 V, Tant   | C0371          |
| C2   | Capacitor, 22 $\mu$ F, 25 V, Tant   | C0371          |
| C3   | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C4   | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C5   | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C6   | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C7   | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C8   | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C9   | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C10  | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C11  | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C12  | Capacitor, 22 $\mu$ F, 25 V, Tant   | C0371          |
| C13  | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C14  | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C15  | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C16  | Capacitor, 22 $\mu$ F, 25 V, Tant   | C0371          |
| C17  | Capacitor, 22 $\mu$ F, 25 V, Tant   | C0371          |
| C18  | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| C19  | Capacitor, .01 $\mu$ F, 150 V, Tant | C0233          |
| CR1  | Diode, 1N4151                       | CR0150         |
| CR2  | Diode, 1N4151                       | CR0150         |
| Q1   | Transistor, 2N5179                  | Q0269          |
| Q2   | Transistor, 2N4258                  | 26004011       |
| Q3   | Transistor, 2N4258                  | 26004011       |
| Q4   | Transistor, 2N5179                  | Q0269          |
| Q5   | Transistor, 2N4258                  | 26004011       |
| Q6   | Transistor, 2N4258                  | 26004011       |
| R1   | Resistor, 20 $\Omega$ , 1/4 W, 5%   | R2417          |
| R2   | Resistor, 200 $\Omega$ , 1/4 W, 5%  | R0736          |
| R3   | Resistor, 330 $\Omega$ , 1/2 W, 5%  | R0315          |
| R4   | Resistor, 39 $\Omega$ , 1/4 W, 5%   | R1552          |
| R5   | Resistor, 390 $\Omega$ , 1/4 W, 5%  | R0880          |
| R6   | Resistor, 39 $\Omega$ , 1/4 W, 5%   | R1552          |
| R7   | Resistor, 20 $\Omega$ , 1/4 W, 5%   | R2417          |
| R8   | Resistor, 200 $\Omega$ , 1/4 W, 5%  | R0736          |
| R9   | Resistor, 1 k, 1/4 W, 5%            | R0765          |
| R10  | Resistor, 330 $\Omega$ , 1/4 W, 5%  | R0662          |



## A12, 50 MHz DECADE &amp; GATE PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R11  | Resistor, 390 $\Omega$ , 1/4 W, 5% | R0880          |
| R12  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R13  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R14  | Resistor, 2.2 k, 1/4 W, 5%         | R0749          |
| R15  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| U1   | Integrated Circuit, MC3002P        | 25739          |
| U2   | Integrated Circuit, SN7454N        | 25772          |
| U3   | Integrated Circuit, SN7454N        | 25772          |
| U4   | Integrated Circuit, SN7400N        | 19705          |
| U5   | Integrated Circuit, SN7400N        | 19705          |
| U6   | Integrated Circuit, SN7400N        | 19705          |
| U7   | Integrated Circuit, SN7400N        | 19705          |
| U8   | Integrated Circuit, SN7410N        | 19706          |
| U9   | Integrated Circuit, SN74S00N       | 25785          |
| U10  | Integrated Circuit, SN74S112N      | 25786          |
| U11  | Integrated Circuit, MC3002P        | 25739          |
| U12  | Integrated Circuit, SN74196N       | 25784          |
| U13  | Integrated Circuit, MC3001P        | 25740          |
| U14  | Integrated Circuit, MC3002P        | 25739          |
| U15  | Integrated Circuit, MC3001P        | 25740          |



A16, 50 MHz AMPLIFIER ASSEMBLY #B39718A





A16, 50 MHZ AMPLIFIER SCHEMATIC #C39715A

# A16, 50 MHz AMPLIFIER PARTS LIST

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
|      | 50 MHz Amp. P.C. Assembly          | B39718         |
|      | 50 MHz Amp. P.C. Schematic         | C39715         |
| C1   | Capacitor, 22 $\mu$ F, 25 V        | C0371          |
| C2   | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C3   | Capacitor, 22 $\mu$ F, 25 V        | C0371          |
| C4   | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C5   | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C6   | Capacitor, 22 $\mu$ F, 25 V        | C0371          |
| C7   | Capacitor, .001 $\mu$ F, 1 kV      | C0235          |
| C8   | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C9   | Capacitor, .001 $\mu$ F, 1 kV      | C0371          |
| C10  | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C11  | Capacitor, 27 pf, 500 V            | C0530          |
| C12  | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C13  | Capacitor, 56 pf, 500 V            | C0534          |
| C14  | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C15  | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| C16  | Capacitor, .01 $\mu$ F, 100 V      | C0556          |
| CR1  | Diode, 1N4151                      | CR0150         |
| CR2  | Diode, 1N4151                      | CR0150         |
| CR3  | Diode, 1N4151                      | CR0150         |
| CR4  | FD 300                             | 26012320       |
| CR5  | FD 300                             | 26012320       |
| CR6  | Diode, 1N4151                      | CR0150         |
| CR7  | Diode, 1N4151                      | CR0150         |
| L1   | Reed Coil                          | L0169          |
| L2   | Reed Coil                          | L0174          |
| L3   | Reed Coil                          | L0174          |
| Q1   | Dual FET                           | A39843         |
| Q2   | Transistor, 2N4258                 | 26004011       |
| Q3   | Transistor, 2N4258                 | 26004011       |
| Q4   | Transistor, 2N4258                 | 26004011       |
| Q5   | Transistor, 2N4258                 | 26004011       |
| R1   | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R2   | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R3   | Resistor, 390 $\Omega$ , 1/4 W, 5% | R0880          |
| R4   | Resistor, 10 k, 1/2 W, 5%          | R0292          |
| R5   | Resistor, 390 $\Omega$ , 1/4 W, 5% | R0880          |



# A16, 50 MHz AMPLIFIER PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R6   | Resistor, 1 M, 1/4 W, 5%           | R0962          |
| R7   | Resistor, 270 $\Omega$ , 1/4 W, 5% | R0694          |
| R8   | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R9   | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R10  | Resistor, 180 $\Omega$ , 1/8 W, 5% | R1477          |
| R11  | Resistor, 100 $\Omega$ , 1/4 W, 5% | R0966          |
| R12  | Resistor, 390 $\Omega$ , 1/4 W, 5% | R0880          |
| R13  | Resistor, 180 $\Omega$ , 1/8 W, 5% | R1477          |
| R14  | Resistor, 270 $\Omega$ , 1/4 W, 5% | R0694          |
| R15  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R16  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R17  | Resistor, 1 M, 1/4 W, 5%           | R0962          |
| R18  | Resistor, 30.1 k, 1/4 W, 1%        | R2401          |
| R19  | Resistor, 10 k 15 turn 79 PR       | 01111320       |
| R20  | Resistor, 30.1 k, 1/4 W, 1%        | R2401          |
| R21  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R22  | Resistor, 150 $\Omega$ , 1/4 W, 5% | R0983          |
| R23  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R24  | Resistor, 150 $\Omega$ , 1/4 W, 5% | R0983          |
| R25  | Resistor, 360 $\Omega$ , 1/4 W, 5% | R1571          |
| R26  | Resistor, 100 $\Omega$ , 1/4 W, 5% | R0966          |
| R27  | Resistor, 100 $\Omega$ , 1/4 W, 5% | R0966          |
| S1   | Reed Switch                        | A37288         |
| S2   | Reed Switch                        | S0400          |
| S3   | Reed Switch                        | S0400          |





# Concord Instrument Division

## INSTRUCTION MANUAL



CONCORD INSTRUMENT  
DIVISION  
MODEL 6153  
COUNTER-TIMER

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## WARRANTY

Systron-Donner instruments are warranted during a period of one year from date of shipment to original purchaser to be free from defects in material and workmanship. This warranty does not apply to vacuum tubes, except as they are warranted by tube manufacturers. The liability of Seller under this warranty is limited to replacing or repairing any instrument or component thereof which is returned by Buyer at his expense during such period and which has not been subjected to misuse, neglect, improper installations, repair, alteration, or accident. Seller shall have the right of final determination as to the existence and cause of a defect. In no event shall Seller be liable for collateral or consequential damages. This warranty is in lieu of any other warranty, express, implied or statutory, and no agreement extending or modifying it will be binding upon Seller unless in writing and signed by a duly authorized officer.

## RECEIVING INSPECTION

Every Systron Donner instrument is carefully inspected and is in perfect working order at the time of shipment. Each instrument should be checked as soon as received. If the unit is damaged in any way or fails to operate, a claim should immediately be filed with the transportation company.

## REPAIRS

Whenever a Systron-Donner instrument requires service, the nearest Systron-Donner representative should be contacted; all representatives will provide immediate service or arrange factory returns when necessary.

Please specify both model and serial number in all correspondence concerning Systron-Donner instruments. Address all inquiries on operation or applications to your nearest sales representative or Sales Manager, Instruments, Systron-Donner Corporation, 888 Galindo Street, Concord, California.

CONCORD, CALIFORNIA

*CAUTION*

IMPORTANT OPERATING INSTRUCTIONS  
(200 MHz to 3 GHz)

Signals to the "D" Input (50  $\Omega$ ) connector *MUST NOT EXCEED* +20 dBm (2.2 V rms) at any time or serious (expensive) damage to the input circuit will result. Always monitor unknown signal levels first (terminated in 50  $\Omega$ ), before connecting into the "D" Input of the instrument. When input levels exceed +20 dBm, insert a variable, calibrated attenuator between the signal source and the Model 6153-50.





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CHAPTER 1  
GENERAL INFORMATION

## 1.1 INTRODUCTION

The Model 6153-50 Universal Counter-Timer is a general purpose instrument designed to provide the following functions:

1. Precise FREQUENCY measurements from dc to the 3 GHz region.
2. TOTALIZE (accumulating) capability to 200 MHz.
3. PERIOD and TIME INTERVAL measurements, resolution to 10 nanoseconds.
4. RATIO measurements.
5. MULTIPLE PERIOD and RATIO measurements to  $10^5$  for improved accuracy.
6. SCALING (frequency division) to  $10^9$  in decade steps.

## 1.2 SPECIFICATIONS

Table 1.1 lists the specifications applicable to the Model 6153-50:

TABLE 1.1 SPECIFICATIONS

### FREQUENCY MEASUREMENT (RATE A)

|               |                                                                                                 |
|---------------|-------------------------------------------------------------------------------------------------|
| Range:        | 0 to 200 MHz (dc input).                                                                        |
| Resolution:   | 1 MHz to 0.1 Hz in decade steps as selected by the front panel RESOLUTION-FREQUENCY switches.   |
| Accuracy:     | $\pm 1$ count $\pm$ time base accuracy.                                                         |
| Readout:      | "kHz" or "MHz", with positioned decimal point.                                                  |
| Input Signal: | "A" INPUT.                                                                                      |
| Test:         | Measures 100 MHz internal standard in decade steps with RESOLUTION-FREQUENCY switches selected. |

### SCALING (COUNT A)

|               |                                                                                       |
|---------------|---------------------------------------------------------------------------------------|
| Range:        | dc to 150 MHz.                                                                        |
| Resolution:   | $10$ to $10^9$ in decade steps as selected by the front panel SCALE-COUNT A switches. |
| Input Signal: | "A" INPUT.                                                                            |

TABLE 1.1 SPECIFICATIONS (Cont'd)

## SCALING (COUNT A) Cont'd

Output: At Time Base/SCALE OUTput connector.

## TIME INTERVAL (TIM B-C)

Range: 100 ns to  $10^8$  seconds.

Resolution: 10 ns to 1 second in decade steps as selected by the front panel RESOLUTION-TIME switches.

Accuracy (Pulse):  $\pm 1$  period of the selected frequency counted  $\pm$  time base accuracy.

Readout: Seconds, milliseconds, microseconds, with positioned decimal point.

Input Signals: "B" INPUT and "C" INPUT.

## PERIOD (PERIOD B)

Range: Single period, dc to 10 MHz.  
Multiple period, dc to 10 MHz.

Periods Averaged: 1 period to  $10^5$  periods, in decade steps.

Frequency Counted: Single and multiple, 100 MHz to 1 Hz, in decade steps.

Accuracy:  $\pm 1$  count  $\pm$  time base accuracy  $\pm$  trigger error\*.

Readout: Seconds, milliseconds, microseconds, with positioned decimal point.

Input Signal: "B" INPUT.

Test: Tests operation, 1 period to  $10^5$  periods.

## RATIO (RATIO A/B x M)

Displays: "A" Input/"B" Input times selected multiplier (multiplier = 1 to  $10^5$ ).

Range: "A" INPUT: dc to 200 MHz. "B" INPUT: 0 to 10 MHz (single or multiple ratio; ratios averaged 1 to  $10^5$  in decade steps).



TABLE 1.1 SPECIFICATIONS (Cont'd)

## RATIO (RATIO A/B x M) Cont'd

|                |                                                                         |
|----------------|-------------------------------------------------------------------------|
| Accuracy:      | $\pm 1$ count of "A" INPUT $\pm$ trigger error* of "B" INPUT.           |
| Readout:       | Dimensionless (positioned decimal point for number of ratios averaged). |
| Input Signals: | "A" INPUT (Numerator); "B" INPUT (Denominator).                         |
| Test:          | Same as Period Averaged test.                                           |

## FREQUENCY MEASUREMENT (RATE D)

|               |                                               |
|---------------|-----------------------------------------------|
| Range:        | 200 MHz to 3 GHz.                             |
| Type Signal:  | CW.                                           |
| Resolution:   | 1 MHz to 0.1 Hz, in decade steps.             |
| Accuracy:     | $\pm 1$ count $\pm$ time base accuracy.       |
| Readout:      | "kHz" or "MHz" with positioned decimal point. |
| Input Signal: | "D" INPUT.                                    |

## GENERAL

|                                    |                                                                                                                                                                                                                                                   |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Display:                           | 8 digits in-line; 99,999,999 maximum display.                                                                                                                                                                                                     |
| Storage:                           | Provides continuous display of most recent measurement; rear panel switch overrides storage feature.                                                                                                                                              |
| Gate Light:                        | Provides visual indication of main-counter gate operation.                                                                                                                                                                                        |
| Off Scale Light (OS):              | Provides visual indication when display register has been exceeded.                                                                                                                                                                               |
| Invalid Switch Position Light (*): | Lights when FUNCTION and RESOLUTION switches are in unallowable positions.                                                                                                                                                                        |
| Recycle Rate:                      | Controls time from end of measurement to the start of new measurement. In SLOW position, variable from less than 60 milliseconds to more than 5 seconds. In FAST position, variable from less than 500 microseconds to more than 60 milliseconds. |

TABLE 1.1 SPECIFICATIONS (Cont'd)

## GENERAL Cont'd

Reset: Front panel pushbutton clears counter and resets display to zero.

## "A" INPUT

Sensitivity: 100 mV rms.

Input Impedance: 1 M $\Omega$  shunted by less than 25 pF.

Coupling: DC or AC, selected by front panel switch.

Attenuation: Step attenuator by factors of 1, 10, or 100.

Trigger Level:  $\pm 1$  V x attenuation factor. A "Preset" position centers the trigger level to approximately 0 V.

Overload: Overload without damage is provided:

- a) 120 V rms in the x 1 position (<1 kHz).
- b) 250 V rms in the x 10 position.
- c) 500 V rms in the x 100 position.

Connector: BNC type.

## "B" INPUT AND "C" INPUT

Sensitivity: 0.3 V p-p.

Input Impedance: 1 M $\Omega$  shunted by less than 35 pF, for input voltages up to three times the attenuator setting.

Coupling: DC or AC, selected by front panel switch.

Attenuation: Step attenuators by factors of 1, 10, or 100.

Trigger Level: Adjustable 3.0 V x attenuation factor. A "Preset" position centers the trigger level to approximately 0 V.

TABLE 1.1 SPECIFICATIONS (Cont'd)

**"B" INPUT AND "C" INPUT Cont'd**

|                  |                                                                                                                                                                                                                               |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Overload:        | Overload without damage is provided: <ul style="list-style-type: none"> <li>a) 120 V rms in the x 1 position (&lt;1 kHz).</li> <li>b) 250 V rms in the x 10 position.</li> <li>c) 500 V rms in the x 100 position.</li> </ul> |
| Trigger Slope:   | POSITIVE or NEGATIVE on Start and Stop inputs, independently selectable.                                                                                                                                                      |
| Separate-Common: | Independent or common channels referred to "B" INPUT.                                                                                                                                                                         |
| Connector:       | BNC type.                                                                                                                                                                                                                     |

**"D" INPUT**

|              |                                                    |
|--------------|----------------------------------------------------|
| Sensitivity: | -13 dBm (50mV rms) minimum.                        |
| Impedance:   | 50 $\Omega$ nominal.                               |
| Type Signal: | CW.                                                |
| Overload:    | Maximum level without damage, +20 dBm (2.2 V rms). |
| Connector:   | Type N.                                            |

**EXT/INT STANDARD FREQUENCY INPUT**

|            |                                                                                                                                                                                                                                 |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input:     | A 1 V rms signal into 1 k $\Omega$ from an external frequency standard can be used if harmonically related to 10 MHz (100 kHz to 10 MHz). For example; 100 kHz, 250 kHz, 500 kHz or 1 MHz signals can be used (INT/EXT switch). |
| Connector: | BNC type.                                                                                                                                                                                                                       |

**EXT/INT TIME BASE**

|            |                                                                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input:     | A 1 V rms signal into 1 k $\Omega$ provides access to the internal Time Base for manual conversion to other units of measure (10 kHz to 10 MHz). Switch selectable (INT/EXT switch). |
| Connector: | BNC type.                                                                                                                                                                            |

TABLE 1.1 SPECIFICATIONS (Cont'd)

**"B" AND "C" MARKER OUTPUTS**

|                   |                                                                     |
|-------------------|---------------------------------------------------------------------|
| Outputs:          | Coincide with Start-Stop triggering of the waveform being measured. |
| Amplitude:        | > 10 V p-p.                                                         |
| Source Impedance: | < 1.5 k $\Omega$ .                                                  |
| Pulse Width:      | < 1.5 microsecond.                                                  |
| Connector:        | BNC type.                                                           |

**GATE OUTPUT**

|                   |                                                                                                |
|-------------------|------------------------------------------------------------------------------------------------|
| Output:           | Coincides with main counter gate operation.                                                    |
| Amplitude:        | > +2.5 V = 1 state (gate open - counting).<br>< +0.8 V = 0 state (gate closed - not counting). |
| Source Impedance: | TTL output.                                                                                    |
| Connector:        | BNC type.                                                                                      |

**TIME BASE/SCALE OUT**

|                   |                                                                                                                                        |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Output:           | Provides output frequencies of 0.1 Hz to 10 MHz selected by front panel resolution switches in the Rate, Period, Tim, and Ratio modes. |
| Amplitude:        | > 1 V p-p.                                                                                                                             |
| Source Impedance: | TTL output.                                                                                                                            |
| Connector:        | BNC type.                                                                                                                              |

**BCD OUTPUT**

|                   |                                                                                                                                    |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Output:           | Four line BCD 1-2-4-8, all indicators, decimals and measurement units.<br>"1" state level: > +3.5 V.<br>"0" state level: < +0.8 V. |
| Impedance:        | TTL output.                                                                                                                        |
| Reference Levels: | Positive reference, +5 V through 1 k $\Omega$ ; negative reference, ground.                                                        |



TABLE 1.1 SPECIFICATIONS (Cont'd)

## BCD OUTPUT Cont'd

|                       |                                                                              |
|-----------------------|------------------------------------------------------------------------------|
| Print Command:        | +12 V to 0 V step. 1 k $\Omega$ source, dc-coupled. Also, 0 V to +12 V step. |
| Hold Off Requirement: | $\geq$ 0 V to +0.8 V to inhibit instrument; $>$ +1.8 V to enable.            |
| Connector:            | Amphenol 50-pin 57-30500-375.                                                |

## TIME BASE

|                             |                                                                                                                                                                                                                                                                  |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Crystal Frequency:          | 3 MHz.                                                                                                                                                                                                                                                           |
| Aging Rate:                 | $<$ 3 parts in $10^9$ per day after 72 hours of continuous powered operation.                                                                                                                                                                                    |
| Short Term:                 | $<$ 2 parts in $10^{10}$ rms with measurement averaging time of one second while under constant environment and line conditions.                                                                                                                                 |
| Temperature:                | $<$ $\pm 2$ parts in $10^{10}$ per degree centigrade from $-10^\circ\text{C}$ to $+50^\circ\text{C}$ .                                                                                                                                                           |
| Line Voltage:               | $<$ $\pm 5$ parts in $10^{10}$ for a $\pm 10\%$ change in line voltage.                                                                                                                                                                                          |
| Adjustment:                 | $\pm 5 \times 10^6$ coarse; $> \pm 4 \times 10^8$ fine, with a setting resolution of $\pm 1 \times 10^9$ on the fine adjust.                                                                                                                                     |
| Retrace:                    | For "Off" periods up to 24 hours;<br>$<$ $\pm 1$ part $10^6$ /hour after 1/2 hour operation.<br>$<$ $\pm 1$ part $10^7$ /hour after 1 hour operation.<br>$<$ $\pm 5$ parts $10^9$ /hour after 2 hours operation.                                                 |
| *TRIGGER ERROR:             | <i>Trigger error is less than 0.3% of one period divided by the number of periods averaged for a 100 mV rms signal with a <math>&gt;</math> 40 dB signal to noise ratio. Error is less with a signal of greater amplitude or improved signal to noise ratio.</i> |
| OPERATING TEMPERATURE RANGE | $0^\circ\text{C}$ to $+50^\circ\text{C}$ .                                                                                                                                                                                                                       |

TABLE 1.1 SPECIFICATIONS (Cont'd)

|                   |                                            |
|-------------------|--------------------------------------------|
| RELATIVE HUMIDITY | 10% to 80%.                                |
| AC LINE VOLTAGE   | 115 V rms or 230 V rms, $\pm 10\%$ , 75 W. |
| AC LINE FREQUENCY | 60 Hz, $\pm 2$ Hz.                         |

### 1.3 DEFINITIONS

#### 1) Aging Rate

Defines the average slope of the fractional frequency change of an oscillator plotted against time (see Figure 1.1).

#### 2) Positive Logic

Activation or true indication takes place when signal changes from low level to high level (see Figure 1.2).

#### 3) Negative Logic

Activation or true indication takes place when signal changes from high level to low level (see Figure 1.2).

### 1.4 APPLICATION

The Model 6153-50 Universal Counter-Timer measures frequencies from 0 to 3 GHz. It can be employed for measurement, analysis, and counting of both periodic and random signals of various waveforms within the rated frequency characteristics of the instrument. Because it operates directly from voltage inputs, it is an indispensable tool for designing, manufacturing, and testing of instruments/circuits having electrical outputs relating to time interval, frequency, or number of occurrences. It is commonly used for the design and calibration of transmitting and receiving equipment, oscillators, tuned circuits, crystals, etc. Because of its accuracy and stability, it is invaluable for checking long term drift and heat-cycling stability of crystals and other signal generators. Other common applications are calibration of resolvers and synchros.

When driven from suitable input transducers such as photo cells, magnetic pickups, or switches, it becomes equally valuable for measuring physical events with respect to time. For example; speed of rotation, flow rate, time delays, or production unit counting are just a few to be considered. In addition, other typical applications include, frequency measurements, relay and switch timing, ballistic measurements, etc.

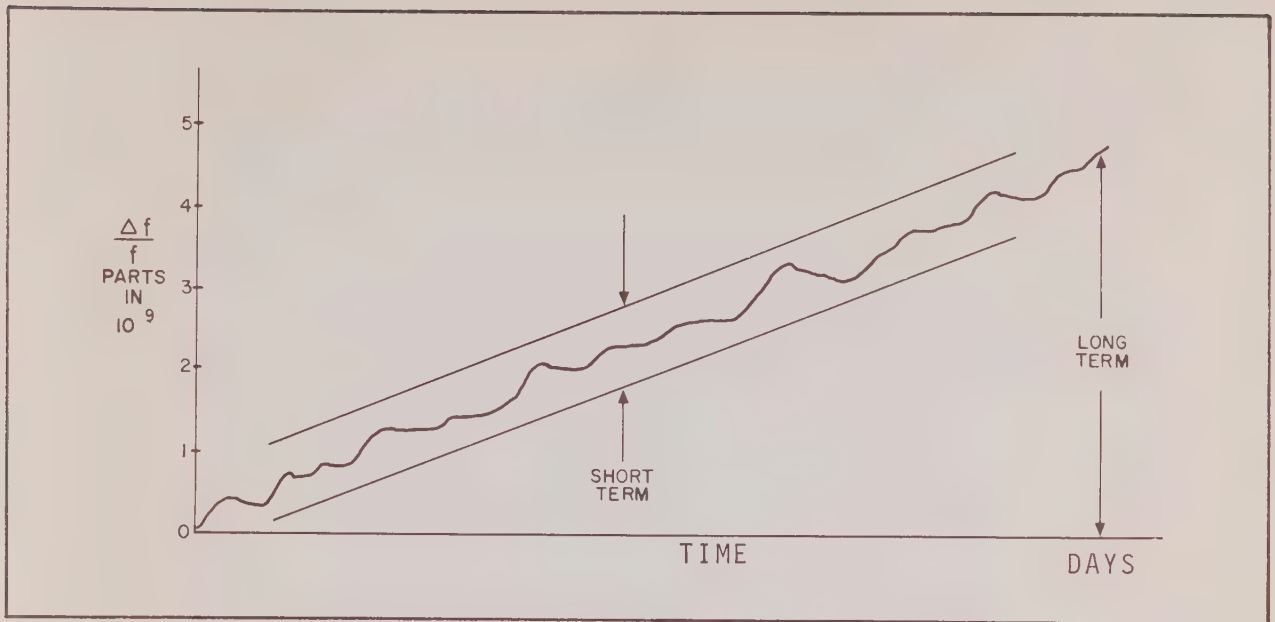


FIGURE 1.1 AGING RATE OF OSCILLATOR

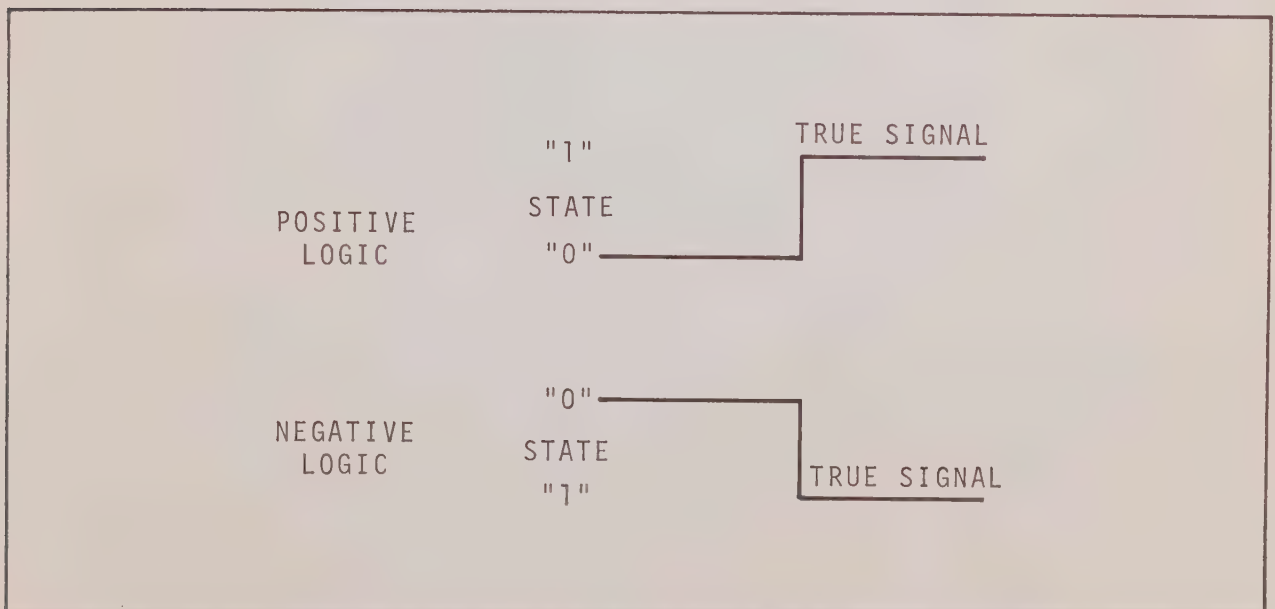


FIGURE 1.2 DEFINITION OF LOGIC LEVELS





## CHAPTER 2

### INSTALLATION

#### 2.1 INTRODUCTION

The Model 6153-50 Universal Counter-Timer is shipped in an operational condition, and is essentially ready for use, as received. This section contains unpacking, inspection, and installation information to aid in setting up the instrument for immediate use.

#### 2.2 RECEIVING INSPECTION

As soon as the instrument is received, check the carton for evidence of damage or rough handling. If damage is found, or is suspected, notify the carrier and your Systron-Donner Representative. Open the shipping container only in their presence.

Use care in removing the instrument from the container. Check immediately for loose or broken control knobs, bent or broken connectors, and dents or scratches on the panel surfaces. If damage of any nature is found, refer to the warranty instructions in the front of this instruction manual.

All Systron-Donner instruments must pass rigid inspection tests before leaving the plant. However, upon receipt, a receiving inspection test should be performed immediately after unpacking to ensure that the instrument is still operational.

#### 2.3 INSTALLATION

##### 2.3.1 Power

The instrument is provided with a 3-conductor power cord which grounds the case when connected through a compatible grounding outlet. If a standard ground outlet is not available, a 3-conductor adapter must be used which provides the necessary grounding connection. Make sure the rear panel 115-230 V switch is in the correct position before connecting the instrument to a power source. Also, be certain that the proper fuse F1 is installed (1 ampere, 115 V ac; .5 ampere, 230 V ac).

##### 2.3.2 Cooling

The Model 6153-50 design incorporates a cooling fan. Cooling air enters the case at the front of the instrument, passing through the internal assemblies; then, exhausts through the fan in the rear panel. Care must be exercised not to obstruct the flow of air into or out of the instrument case, especially when the instrument is resting flat on the bumper feet (tilt stand folded up or removed).

#### NOTE

*If the instrument is to be rack or console-mounted, determine if the stand/bumper feet will interfere; then, remove these items as required. Remove side-dress panel for maximum ventilation.*

## 2.4 STORAGE AND RESHIPMENT

Environmental conditions during storage and shipment should be limited to a maximum temperature of 85°C and a minimum temperature of -55°C.

To protect the instrument during shipment or storage, use the best packaging methods available. Contact the nearest Systron-Donner field office for materials similar to those used in the original factory package. Contract packaging companies are also available to provide dependable custom-packaging service on short notice.

- 1) If possible use the original shipping container designed for the instrument. Otherwise, a strong carton (350 lb f/in<sup>2</sup> bursting strength) or wooden box should provide adequate protection.
- 2) Wrap the instrument in heavy paper or plastic before placing it in the shipping container.
- 3) Completely fill the area around the instrument with packing material; protect the front panel surfaces with several sheets of cardboard.
- 4) Seal the package with strong tape or metal bands. Mark FRAGILE - DELICATE INSTRUMENT on the outside of package.
- 5) Refer to the Warranty in this manual and check with the nearest Systron-Donner field office for shipping instructions. In all correspondence, refer to the instrument by full model number and serial number.

## CHAPTER 3

### OPERATION

#### 3.1 ACCURACY OF MEASUREMENTS

##### 3.1.1 Gating Ambiguity

All types of digital measuring instruments are subject to an irreducible  $\pm 1$  count ambiguity in the least significant digit of the display. This error is possible because the signal counted is not coherent (synchronized) with the time base pulses that control the signal gate. As illustrated in Figure 3.1, the first or last cycle of the input signal may, or may not, pass through the signal gate during the selected measurement interval.

As the measured frequency is increased, the percent of error due to the  $\pm 1$  count ambiguity is reduced since it becomes less significant compared to the total count. In any case, the maximum percentage of error is a function of the frequency measured and the number of pulses counted; i.e., the time base selected, and may be expressed by:

$$\text{Max \% error} = \pm \frac{1}{f \times T} \times 100 \leq 100\%$$

where:  $f$  is the frequency measured in Hz and  $T$  is the selected time base in seconds. Thus to measure 1 MHz with a  $\pm 0.001\%$  maximum gating error, the RESOLUTION-FREQUENCY switch must be set to the 10 Hz position.

##### 3.1.2 Internal Oscillator Stability

The gating precision, and therefore the accuracy of the count, is dependent upon the stability of the internal oscillator.

In the standard instrument, the oscillator is initially set to within  $\pm 1$  part in  $10^9$  of a 1 MHz frequency standard having at least an order of magnitude higher stability.

Deviation of the Model 6153-50 oscillator from this frequency then becomes a function of several factors; the most significant being time. Due to certain processes in the frequency determining elements of the oscillator, an "aging" rate is established that can be measured and specified for the oscillator. This aging rate is specified to be less than  $\pm 3$  parts in  $10^9$  per day after an initial warm-up of 72 hours. Generally, this aging rate decreases with time (providing the instrument remains continuously energized). The error due to oscillator instability may be estimated from:

$$\text{Max \% error} = (\pm 3/10^9 \times D) \times 100$$

where:  $D$  is the number of days since last calibrated.

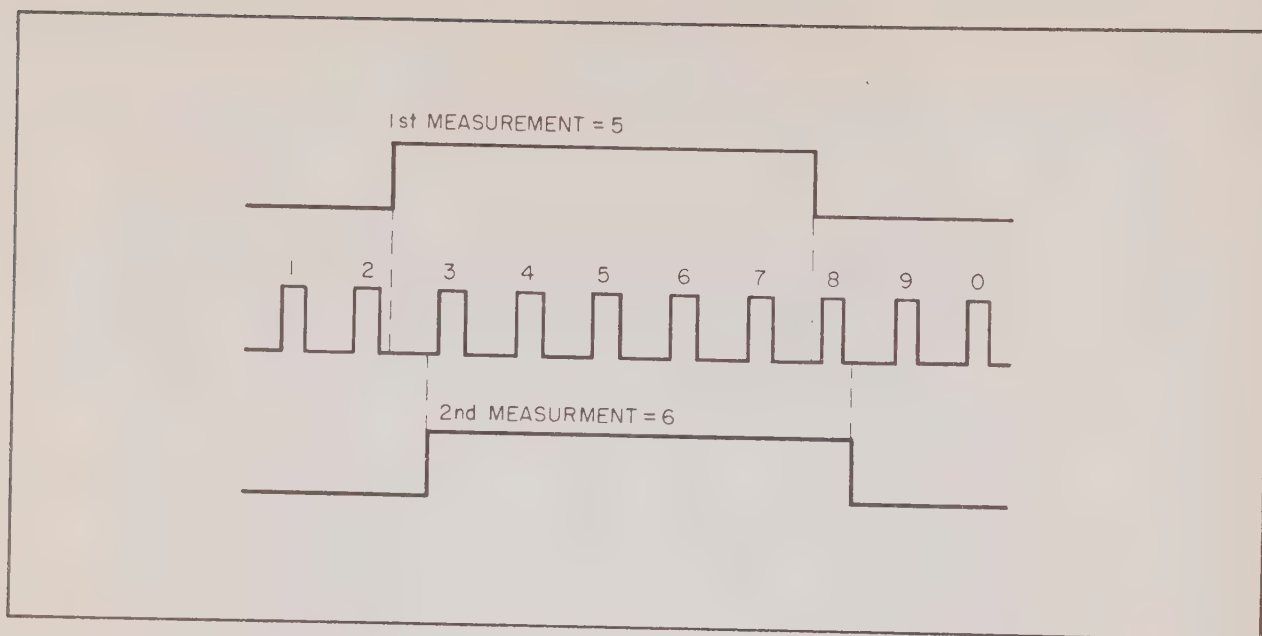


FIGURE 3.1 GATING AMBIGUITY.

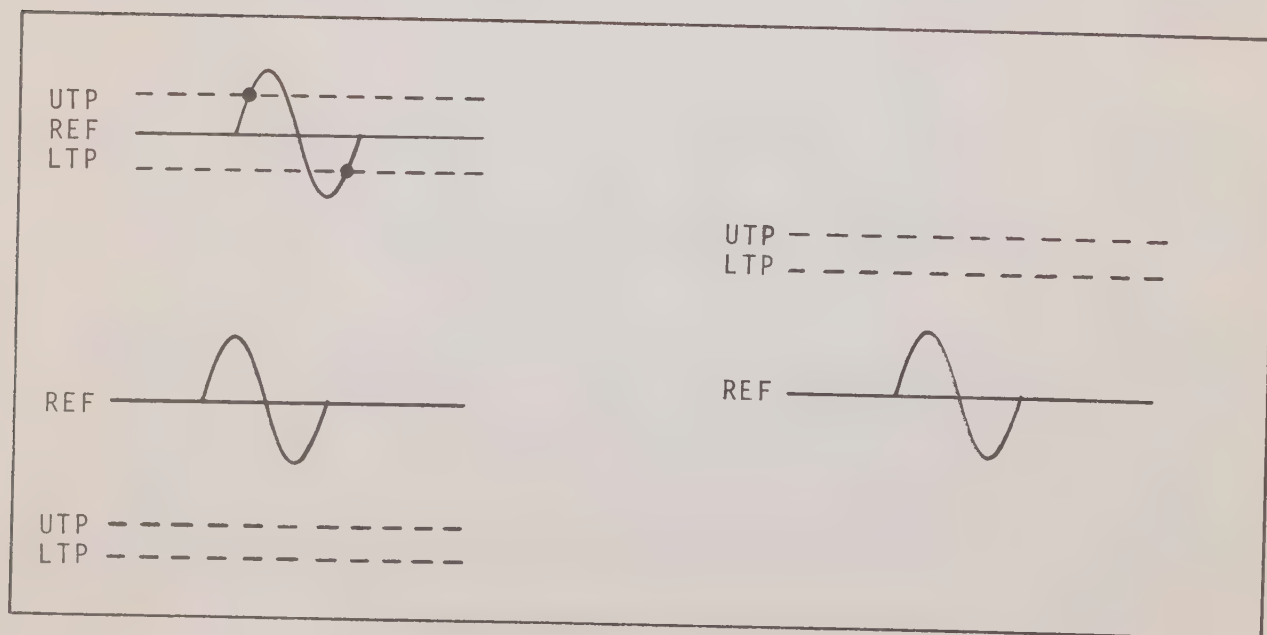


FIGURE 3.2 TRIGGERING LEVELS.



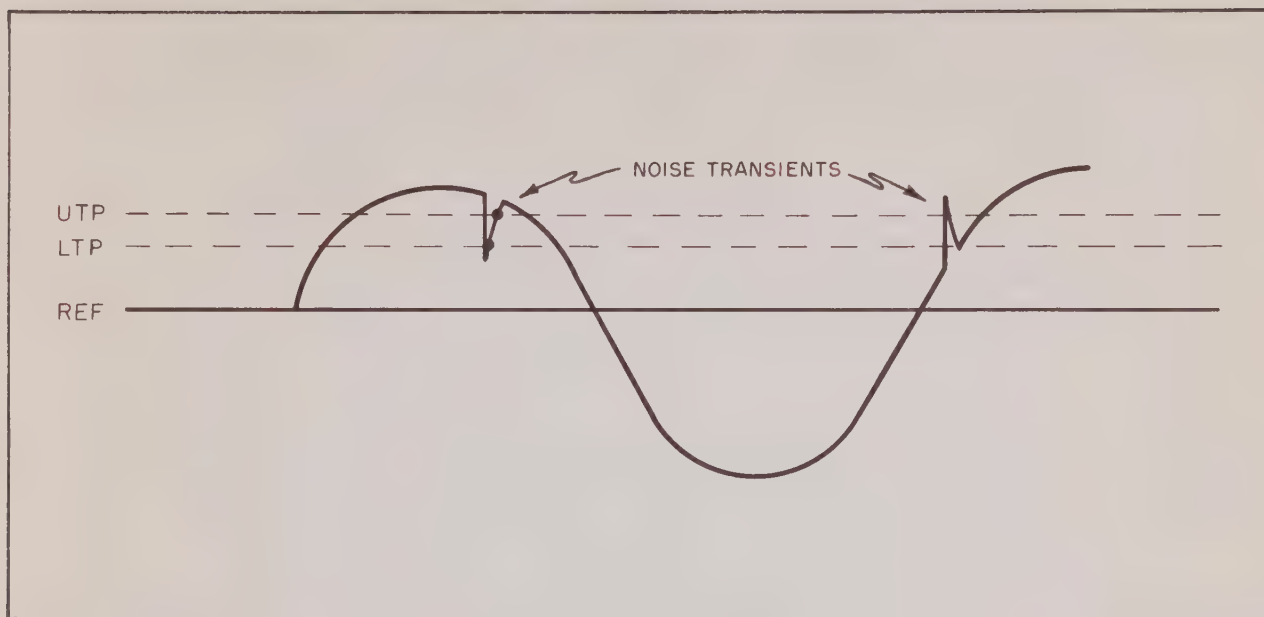


FIGURE 3.3 SPURIOUS COUNTS DUE TO NOISE TRANSIENTS.

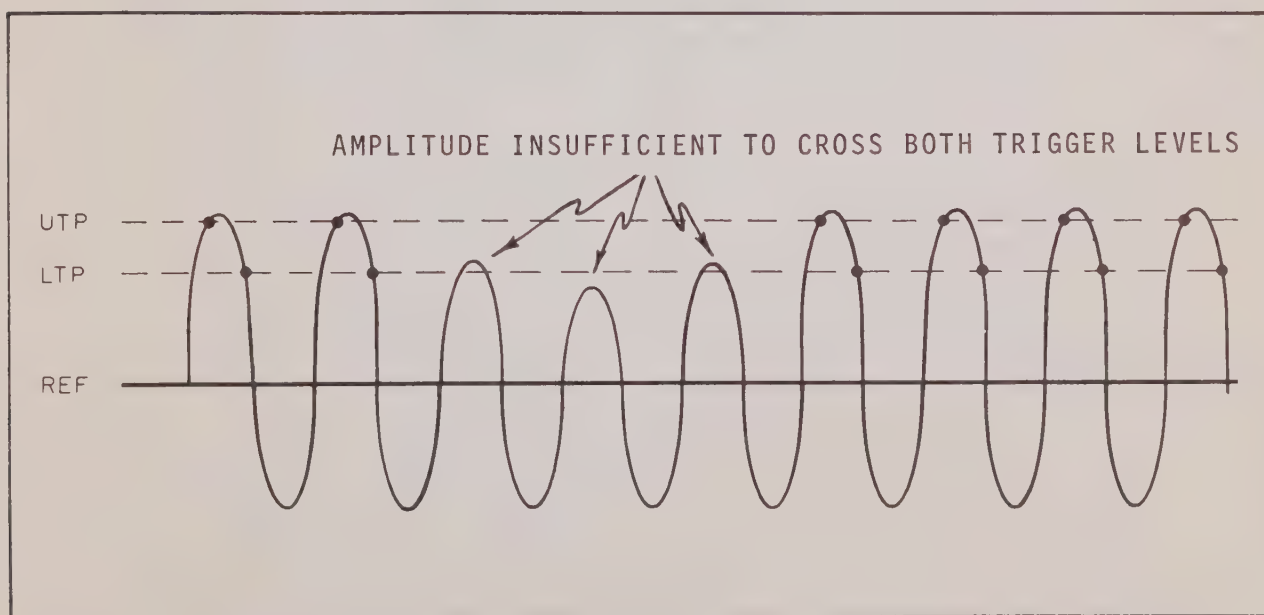


FIGURE 3.4 MISSING COUNTS DUE TO AMPLITUDE MODULATION.

Oscillator stability is also a function of line voltage and temperature; except for the time immediately after calibration, their effect will be several orders of magnitude less than the effect of aging and may be neglected. To achieve the highest accuracy of measurement, the following considerations apply:

- 1) Maintain the instrument plugged-in and continuously energized.
- 2) Maintain constant environmental conditions.
- 3) Monitor or regulate line voltage.
- 4) Calibrate instrument at intervals consistent with maximum allowable error.

### 3.1.3 Level Control Adjustment

Unstable and inaccurate measurements often result from inconsistent triggering of the signal processing circuits. In many cases, this is due to improper adjustment of the LEVEL control for the type of signal being handled. Figure 3.2 illustrates the nominal input triggering level and the effect of the LEVEL control. Note that there is a 0.3 V nominal separation (or hysteresis) between the upper and lower trigger levels; and in operation, the input signal must cross both levels to complete a triggering cycle. The LEVEL control acts to offset the reference level of the input signal.

Generally, the setting of the LEVEL control for sinusoidal inputs should be made at approximately the center of the steepest slope on the input waveform to ensure reliable counting. However, careful attention must be paid to the amplitude/shape of the input signal when non-sinusoidal, unknown, or marginal signals are being measured. It is recommended that an oscilloscope be utilized for signal analysis under these conditions. Figures 3.3 thru 3.6 illustrate a variety of situations leading to inaccurate counting and some possible solutions.

#### 1) PROBLEM:

Spurious counts from superimposed noise transients of sufficient amplitude to cross trigger levels (see Figure 3.3).

#### POSSIBLE SOLUTIONS:

- a. Adjust LEVEL control for triggering on steepest portion of signal slope.
- b. Provide attenuation (either internal or external) to reduce noise peaks below trigger hysteresis (0.3 V).
- c. Connect low pass filter between signal source and instrument input.

#### 2) PROBLEM:

Missing count due to amplitude modulation of input signal (see Figure 3.4).

#### POSSIBLE SOLUTION:

- a. Adjust LEVEL control for triggering on steepest portion of slope. Signal amplitude in modulation

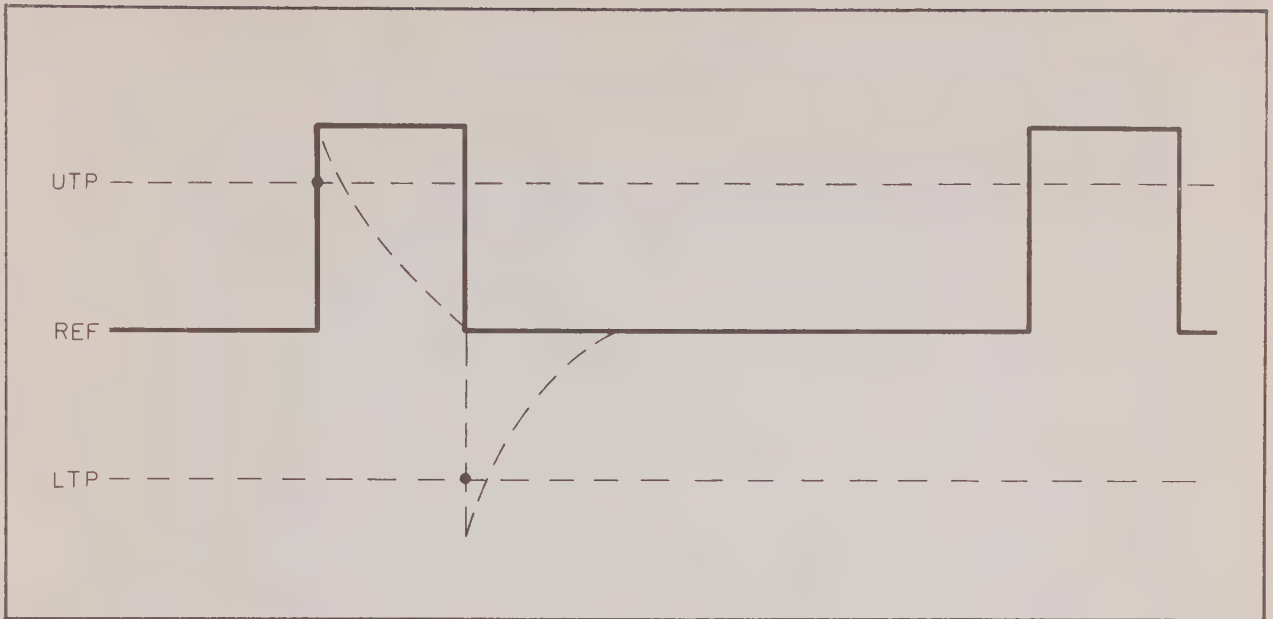


FIGURE 3.5 MONOPOLAR PULSES INTERSECTING ONLY ONE TRIGGER LEVEL.

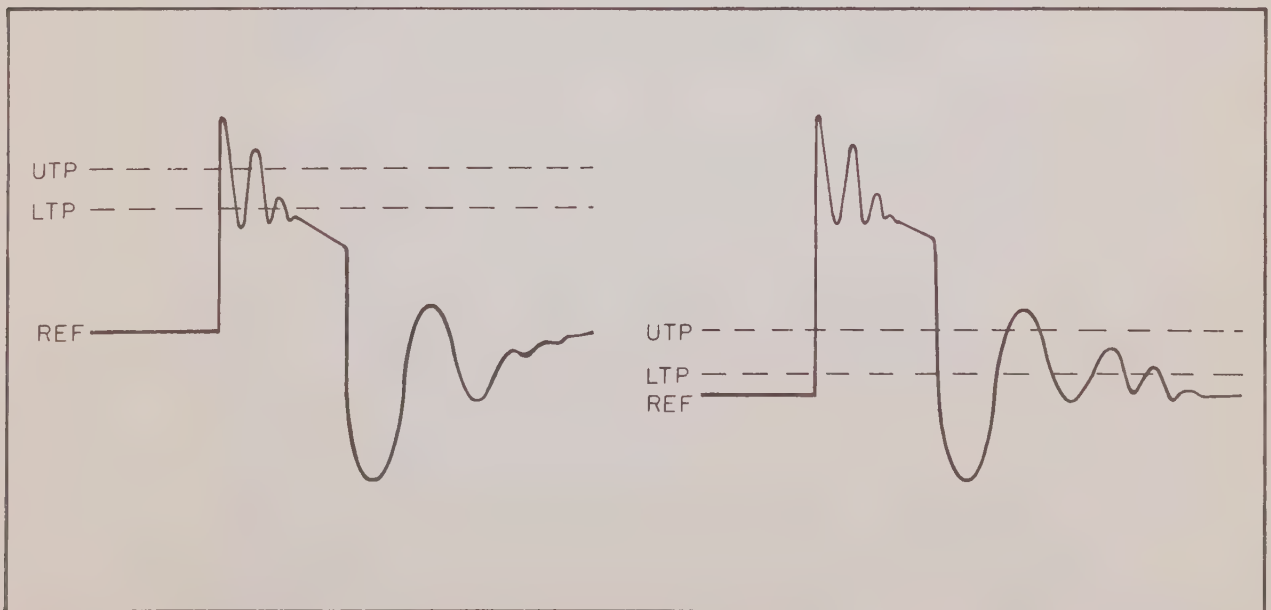


FIGURE 3.6 RINGING ON PULSE WAVEFORM CAUSES COUNT ERROR.

trough must be sufficient to cross both trigger levels.

3) PROBLEM:

Monopolar pulses intersect only one triggering level (see Figure 3.5).

POSSIBLE SOLUTIONS:

- a. Offset LEVEL control so that pulses intersect both levels. Pulse amplitude must be greater than hysteresis value (0.3 V).
- b. Externally differentiate the pulses.

4) PROBLEM:

Ringings on leading and trailing edges of signal pulse. Usually a result of mismatch between instrument input and signal source when source impedance is 50 or 75  $\Omega$  (see Figure 3.6).

POSSIBLE SOLUTION:

- a. Properly terminate input signal cable at INPUT connector on front panel of instrument (usually a 50 or 75  $\Omega$  termination in shunt with INPUT).

### 3.1.4 Period Measurements

For high frequency measurements, the  $\pm 1$  count gating error is insignificant compared to the total count. At low frequencies, however, the error may become important. For this reason the period mode of measurement is normally used to obtain greater accuracy. Figure 3.7 shows which type of measurement will yield the lowest gating error.

Gating error can be reduced by a factor of 10 or more by extending the interval of measurement (Period  $\times 10$ , etc). The total count is multiplied by  $10^n$ , but the gating error in each case remains  $\pm 1$  count.

For example, if a 10 kHz signal is measured over a 0.1 second time base, the count indicated would be 1000  $\pm 1$  and the percentage of error would be  $\pm 0.1\%$ . Measured over a 1 second time base, the count indicated would be 10000  $\pm 1$  and the percentage of error would be reduced to  $\pm 0.01\%$ .

Period and related time-interval measurements are subject to a trigger time-error caused by noise on the input signal (see Figure 3.8). The total signal may be considered as an ideal noise-free signal with a superimposed noise component. The noise, added to the ideal signal, may trigger the channel before or after the selected instant for triggering. The maximum error in time for a given peak-to-peak noise voltage on the slope of an ideal signal at the trigger level is:

$$t = \frac{V_n}{S}$$



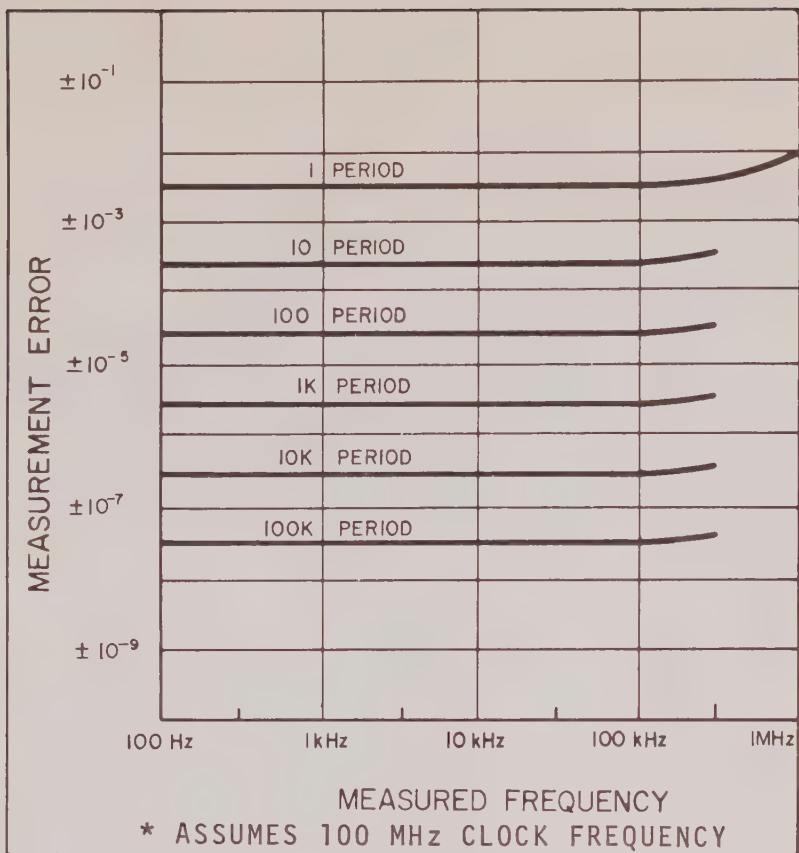


FIGURE 3.7 PERIOD MEASUREMENT ERROR

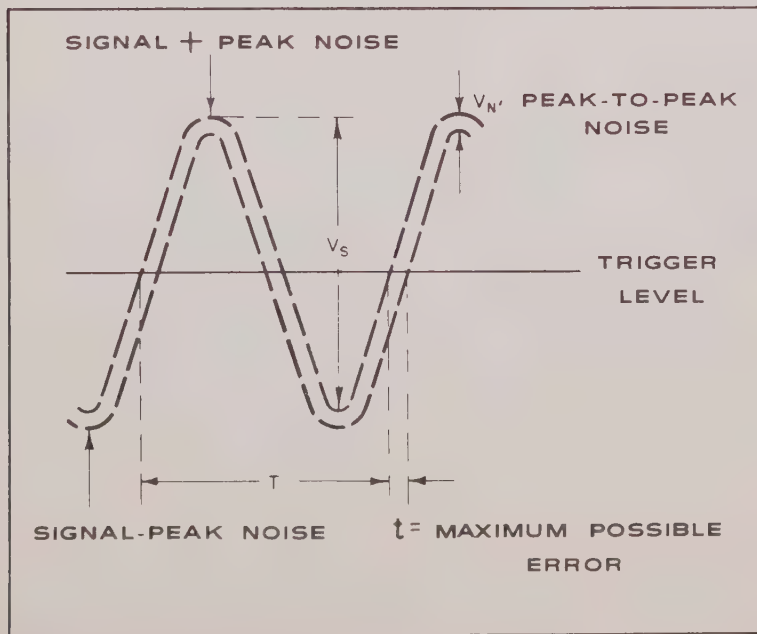


FIGURE 3.8 PERIOD AND TIM TRIGGERING ERROR CAUSED BY SIGNAL NOISE.

The maximum percent error is:

$$\text{Max. \% error} = \frac{t \times 100}{T}$$

For a sine wave triggering at its zero cross-over point:

$$\text{Max. \% error} = \frac{V_n \times 100}{V_s}$$

Where:  $t$  = maximum trigger error (seconds).  
 $V_n$  = peak-to-peak noise (volts).  
 $S$  = slope of ideal signal (volts/second).  
 $T$  = actual period of signal (seconds).  
 $V_s$  = peak-to-peak signal (volts).

## 3.2 CONTROLS, CONNECTORS AND INDICATORS

### 3.2.1 Front Panel

Front panel control functions for the Model 6153-50 are described in this section as follows (see Figure 3.9):

- |                                           |                                                                     |
|-------------------------------------------|---------------------------------------------------------------------|
| 1) POWER (Toggle Switch):                 | Applies ac power to instrument.                                     |
| 2) TEST (Pushbutton):                     | Test instrument in Rate A, Ratio, Period, Count, and Rate D.        |
| 3) RESOLUTION (Pushbuttons):              | Selects time base and clock frequencies, dependent on function.     |
| 4) RESET (Pushbutton):                    | Resets display to zero.                                             |
| 5) FAST-SLOW (Slide Switch):              | Selects range of Recycle Rate control.                              |
| 6) RECYCLE RATE<br>(Potentiometer/Switch) | Varies sample rate of instrument.                                   |
| 7) FUNCTION (Rotary Switch):              | Selects major measurement function to be performed.                 |
| 8) "A" INPUT (Connector, BNC):            | Connects input signal for Rate A, Count, Scale and Ratio numerator. |
| 9) DC-AC (Slide Switch):                  | Selects dc or ac coupling to "A" INPUT amplifier.                   |
| 10) ATTENUATOR (Slide Switch):            | Selects attenuation factor for "A" INPUT amplifier.                 |
| 11) LEVEL (Potentiometer/Switch):         | Adjusts trigger level for "A" INPUT amplifier.                      |

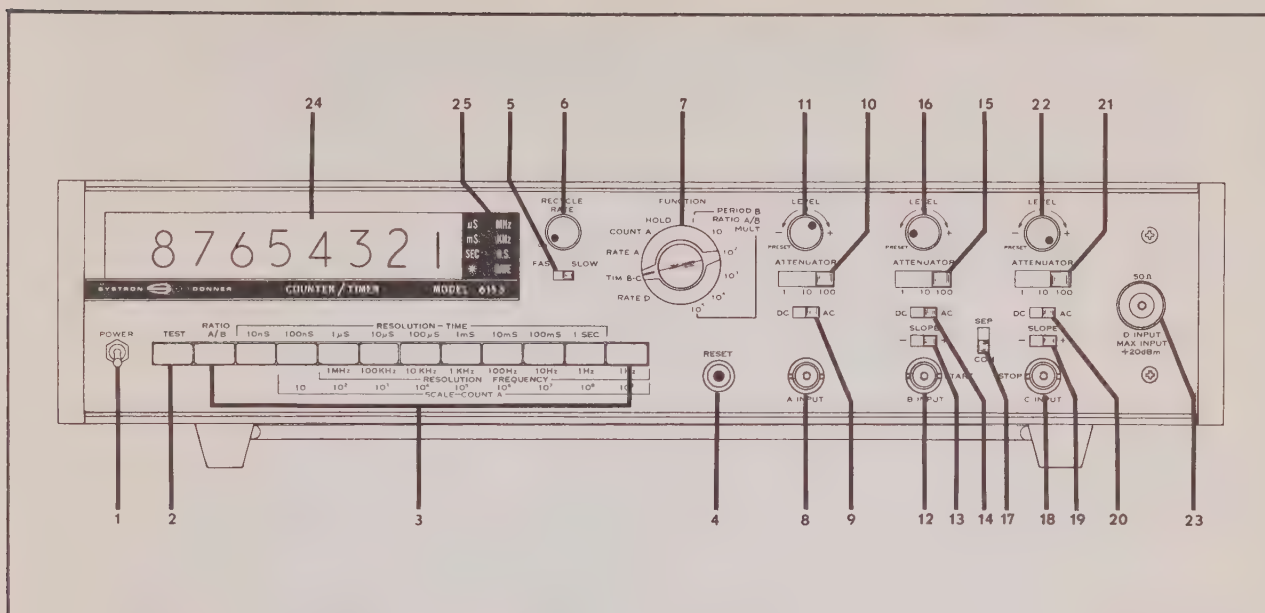


FIGURE 3.9 FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS.

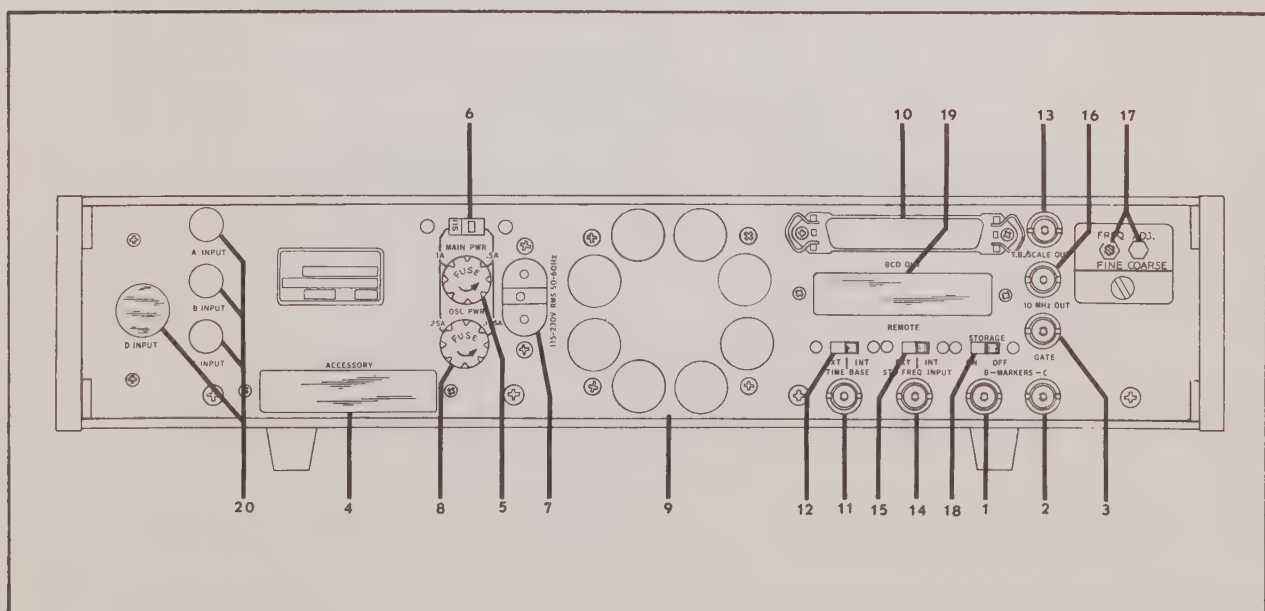


FIGURE 3.10 REAR PANEL CONTROLS, INPUTS, AND OUTPUTS.

- 12) "B" INPUT (Connector, BNC): Connects input for Period and Multiple Period, Ratio denominator, and TIM start.
- 13) SLOPE (Slide Switch): Selects triggering polarity of "B" INPUT Signal.
- 14) DC-AC (Slide Switch): Selects dc or ac coupling to "B" INPUT amplifier.
- 15) ATTENUATOR (Slide Switch): Selects attenuation factor for "B" INPUT amplifier.
- 16) LEVEL (Potentiometer/Switch): Adjusts trigger level for "B" INPUT amplifier.
- 17) SEPARATE-COMMON (Slide Switch): Connects "B" INPUT amplifier and "C" INPUT amplifier in parallel through the "B" INPUT connector; simultaneously disconnects the "C" INPUT connector. When set to the Separate position, "B" INPUT and "C" INPUT are isolated.
- 18) "C" INPUT (Connector, BNC): Connects Stop signal for TIM.
- 19) SLOPE (Slide Switch): Selects triggering polarity of "C" INPUT signal.
- 20) DC-AC (Slide Switch): Selects dc or ac coupling to "C" INPUT amplifier.
- 21) ATTENUATOR (Slide Switch): Selects attenuation factor for "C" INPUT amplifier.
- 22) LEVEL (Potentiometer/Switch): Adjusts trigger level for "C" INPUT amplifier.
- 23) "D" INPUT (Connector, Type N): Connects input signal for RATE "D" measurements.
- 24) READOUT INDICATORS: 8-digit in-line, 99,999,999 maximum display.
- 25) READOUT ANNUNCIATOR: Indicates units of measurement;  $\mu$ S, mS, SEC, \*(Invalid Switch position), MHz, KHz, O.S. (Off Scale), and GATE.



### 3.2.2 Rear Panel

Rear Panel control functions for the Model 6153-50 are described in this section as follows (see Figure 3.10):

- 1) "B" MARKER (Connector, BNC): Provides signal for oscilloscope triggering or modulation.
- 2) "C" MARKER (Connector, BNC): Provides signal for oscilloscope triggering or modulation.
- 3) GATE (Connector, BNC): Main count gate output.
- 4) ACCESSORY (Cover Plate): Optional equipment.
- 5) FUSE (Holder): Main power fuse F1 (1 ampere, 115 V ac, .5 ampere, 230 V ac).
- 6) MAIN POWER 115 V/230 V (Switch): Adapts instrument to 115 V ac or 230 V ac power input.
- 7) POWER CORD (Receptacle): Connects to main line-power (115/230 V ac, 50/60 Hz).
- 8) FUSE (Holder): Oscillator power supply fuse F2 (.25 ampere, 115/230 V ac).
- 9) FAN: Cooling for internal components and assemblies.
- 10) BCD OUT (Connector, 50 Pins): Provides BCD output for digital recorder.
- 11) EXT/INT TIME BASE (Connector, BNC): Provides external access to instrument Time Base for manual conversion to other units of measure (frequencies 10 kHz to 10 MHz). Operating mode (EXT/INT) selected by slide switch.
- 12) EXT/INT TIME BASE (Slide Switch): Selects external or internal frequency for time base (see Item 11 above).
- 13) TIME BASE SCALE OUTPUT (Connector, BNC): Provides time base or divided frequency as set by Resolution & Function switches.
- 14) EXT/INT STD. FREQUENCY INPUT (Connector, BNC): Accepts frequency standard signals which are harmonically related to 10 MHz. Operating mode (EXT/INT) selected by slide switch.

TABLE 3.1A BCD OUTPUT PIN ASSIGNMENTS

| Numerical Indication<br>on Counter | BCD | PIN | Numerical Indication<br>on Counter | BCD        | PIN        |
|------------------------------------|-----|-----|------------------------------------|------------|------------|
| $10^0$                             | 1   | 1   | $10^5$                             | 1          | 11         |
|                                    | 2   | 2   |                                    | 2          | 12         |
|                                    | 4   | 26  |                                    | 4          | 36         |
|                                    | 8   | 27  |                                    | 8          | 37         |
| $10^1$                             | 1   | 3   | $10^6$                             | 1          | 13         |
|                                    | 2   | 4   |                                    | 2          | 14         |
|                                    | 4   | 28  |                                    | 4          | 38         |
|                                    | 8   | 29  |                                    | 8          | 39         |
| $10^2$                             | 1   | 5   | $10^7$                             | 1          | 15         |
|                                    | 2   | 6   |                                    | 2          | 16         |
|                                    | 4   | 30  |                                    | 4          | 40         |
|                                    | 8   | 31  |                                    | 8          | 41         |
| $10^3$                             | 1   | 7   | ANNUNCIATOR                        | 1          | 17         |
|                                    | 2   | 8   |                                    | 2          | 18         |
|                                    | 4   | 32  |                                    | 4          | 42         |
|                                    | 8   | 33  |                                    | 8 (Gnd)    | 43         |
| $10^4$                             | 1   | 9   | ANNUNCIATOR TRANSLATIONS           |            |            |
|                                    | 2   | 10  | Measurement: *                     | = Binary 0 |            |
|                                    | 4   | 34  | MHz                                | = Binary 1 |            |
|                                    | 8   | 35  | KHz                                | = Binary 2 |            |
|                                    |     |     | sec                                | = Binary 3 |            |
|                                    |     |     | ms                                 | = Binary 4 |            |
|                                    |     |     | us                                 | = Binary 5 |            |
| RECORDER CONTROL                   |     |     | DECIMAL POINT                      | 1          | 19         |
| + Reference                        |     | 25  |                                    | 2          | 20         |
| - Reference                        |     | 24  |                                    | 4          | 44         |
| Instrument Gnd                     |     | 50  |                                    | 8          | 45         |
| + Print Command                    |     | 23  | DECIMAL TRANSLATION                |            |            |
| Reset Inhibit                      |     | 47  | Readout                            | $10^0$     | = Binary 0 |
| - Print Command                    |     | 48  | Location                           | $10^1$     | = Binary 1 |
| Inhibit Store                      |     | 46  |                                    | $10^2$     | = Binary 2 |
|                                    |     |     |                                    | $10^3$     | = Binary 3 |
|                                    |     |     |                                    | $10^4$     | = Binary 4 |
|                                    |     |     |                                    | $10^5$     | = Binary 5 |
|                                    |     |     |                                    | $10^6$     | = Binary 6 |
|                                    |     |     |                                    | $10^7$     | = Binary 7 |

TABLE 3.1B  
REMOTE PROGRAMMING PIN ASSIGNMENTS  
(Single Line Selection - Grounded Line True)

| Pin No. | Function              | Pin No. | Function                       |
|---------|-----------------------|---------|--------------------------------|
| 1       | Test                  | 25      | Attenuator X1                  |
| 2       | Ratio                 | 26      | Attenuator X10                 |
| 3       | 10ns                  | 27      | Attenuator X100                |
| 4       | 100ns                 | 28      | Coupling DC                    |
| 5       | 1 $\mu$ s             | 29      | Attenuator X1                  |
| 6       | 10 $\mu$ s            | 30      | Attenuator X10                 |
| 7       | 100 $\mu$ s           | 31      | Attenuator X100                |
| 8       | 1ms                   | 32      | Coupling DC                    |
| 9       | 10ms                  | 33      | Slope Negative                 |
| 10      | 100ms                 | 34      | Attenuator X1                  |
| 11      | 1s                    | 35      | Attenuator X10                 |
| 12      | .1Hz                  | 36      | Attenuator X100                |
| 13      | Fast Recycle          | 37      | Coupling DC                    |
| 14      | TIM                   | 38      | Slope Negative                 |
| 15      | Rate D                | 39      | Common "B" & "C" Amplifiers    |
| 16      | Rate A                | 40      | Demand Reset                   |
| 17      | Count A               | 41      | No Connection                  |
| 18      | Hold                  | 42      | No Connection                  |
| 19      | P/R x 1               | 43      | No Connection                  |
| 20      | P/R x 10              | 44      | No Connection                  |
| 21      | P/R x 10 <sup>2</sup> | 45      | No Connection                  |
| 22      | P/R x 10 <sup>3</sup> | 46      | No Connection                  |
| 23      | P/R x 10 <sup>4</sup> | 47      | Remote Control Amplifiers      |
| 24      | P/R x 10 <sup>5</sup> | 48      | Remote Control Function & T.B. |
|         |                       | 49      | Ground                         |
|         |                       | 50      | Ground                         |

"A" Amp.

"B" Amp.

"C" Amp.

- |     |                                                                  |                                                                                                          |
|-----|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| 15) | EXT/INT STD. FREQUENCY INPUT<br>(Slide Switch):                  | Selects internal/external frequency standard (see Item 14 above).                                        |
| 16) | 10 MHz OUTPUT<br>(Connector, BNC):                               | Provides frequency standard output.                                                                      |
| 17) | FREQUENCY ADJUST<br>(Coarse, Fine):                              | Internal time base frequency adjustment.                                                                 |
| 18) | STORAGE ON/OFF<br>(Slide Switch):                                | Holds previous display while new count is being made. May be disabled by turning switch to OFF position. |
| 19) | REMOTE (Cover Plate):                                            | Optional equipment.                                                                                      |
| 20) | "A" INPUT, "B" INPUT,<br>"C" INPUT, "D" INPUT<br>(Cover Plates): | Optional equipment.                                                                                      |

### 3.3 BCD OUTPUTS

BCD outputs of measurement readings in the front panel display window are simultaneously available at the rear panel BCD OUT connector. These outputs are listed in Table 3.1.

### 3.4 COUNTER INPUT IMPEDANCE

As illustrated in Figure 3.11 the counter input impedance decreases at higher frequencies. This decrease is due to capacitive loading effects of the input amplifier and stray capacities of the input circuit. If a signal source of fixed impedance is connected to the counter input, a meter at the signal source will not indicate the true input level at the counter input. To avoid this error, the level at the counter input should be monitored with a high impedance voltmeter to ensure a satisfactory input level.

### 3.5 INITIAL TURN-ON AND CHECKOUT PROCEDURES

The following procedures may be used to verify operation of the instrument after initial installation, or after long periods of shutdown. When installing the instrument for the first time, check the rear panel MAIN PWR. switch to be certain the proper line voltage is indicated (115 VAC/230 VAC). Install the instrument power cord in the proper outlet; then allow the crystal oven at least one hour to stabilize before making functional measurements. (Oscillator stability is optimized by leaving the instrument power cord connected to the power outlet at all times.) Calibrate the oscillator against a secondary frequency standard after the instrument is stabilized, and at regular intervals thereafter.



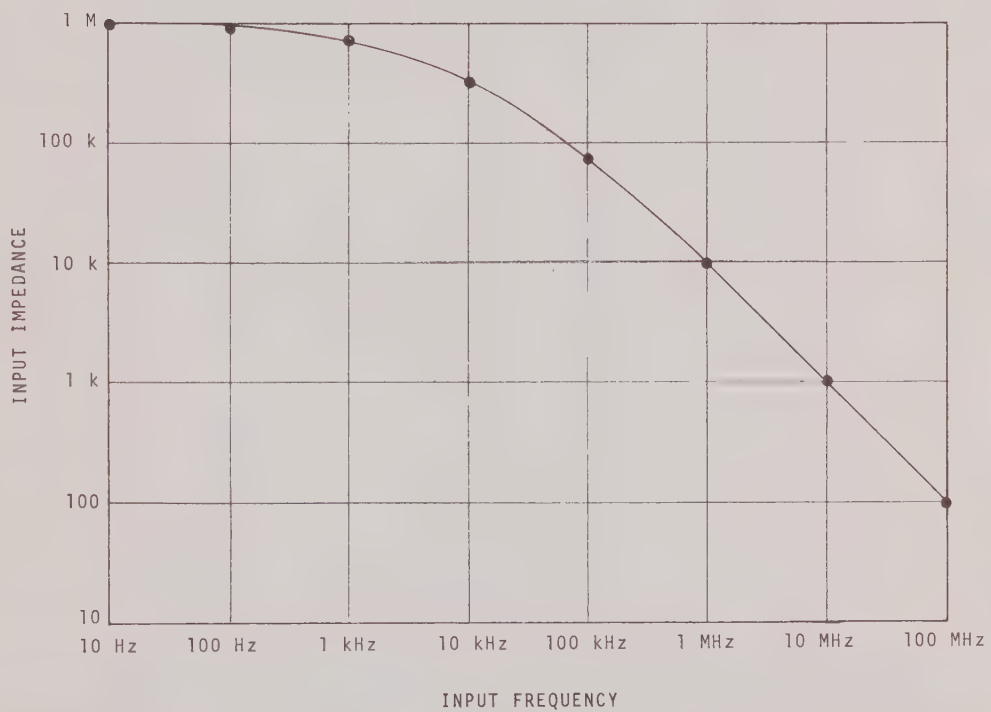


FIGURE 3.11 INPUT IMPEDANCE vs INPUT FREQUENCY

### 3.5.1 Functional Checkout-Rate A/Rate D (Figure 3.12)

- 1) Turn instrument POWER switch to the ON position.
- 2) Press TEST pushbutton.
- 3) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 4) Turn the FUNCTION switch to the RATE A or RATE D position.
- 5) Press the RESOLUTION pushbuttons (1 MHz to 0.1 Hz consecutively), and note the test readings. Compare these readings with the data shown in Table 3.2.

### 3.5.2 Functional Checkout-Period/Mult. Period (Figure 3.12)

- 1) Turn instrument POWER switch to the ON position.
- 2) Press TEST pushbutton.
- 3) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 4) Turn the FUNCTION switch to the PERIOD positions (PERIOD x 1 to PERIOD x  $10^5$  consecutively), and compare the test readings with the data shown in Table 3.3.

### 3.5.3 Functional Checkout-Ratio/Mult. Ratio (Figure 3.12)

- 1) Turn instrument POWER switch to the ON position.
- 2) Press TEST and RATIO A/B pushbutton.
- 3) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 4) Turn the FUNCTION switch to the RATIO positions (RATIO 1 to RATIO x  $10^5$  consecutively), and compare the test readings with the data shown in Table 3.4.

### 3.6 DC TO 200 MHz FREQUENCY MEASUREMENT-RATE A (Figure 3.13)

- 1) Turn instrument POWER switch to the ON position.
- 2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 3) Turn the FUNCTION switch to the RATE A position.
- 4) Press desired RESOLUTION pushbutton (1 MHz to 0.1 Hz). Check to be certain that TEST pushbutton is deactivated.
- 5) Turn the "A" INPUT LEVEL control to the PRESET position.

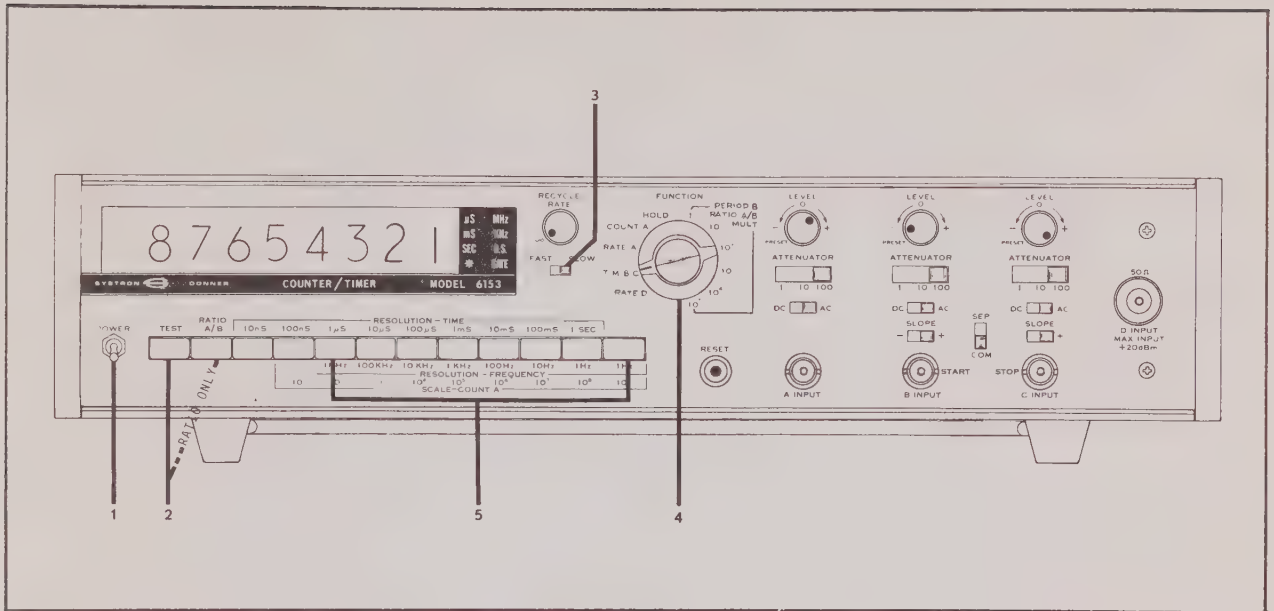


FIGURE 3.12 INITIAL TEST PROCEDURES.

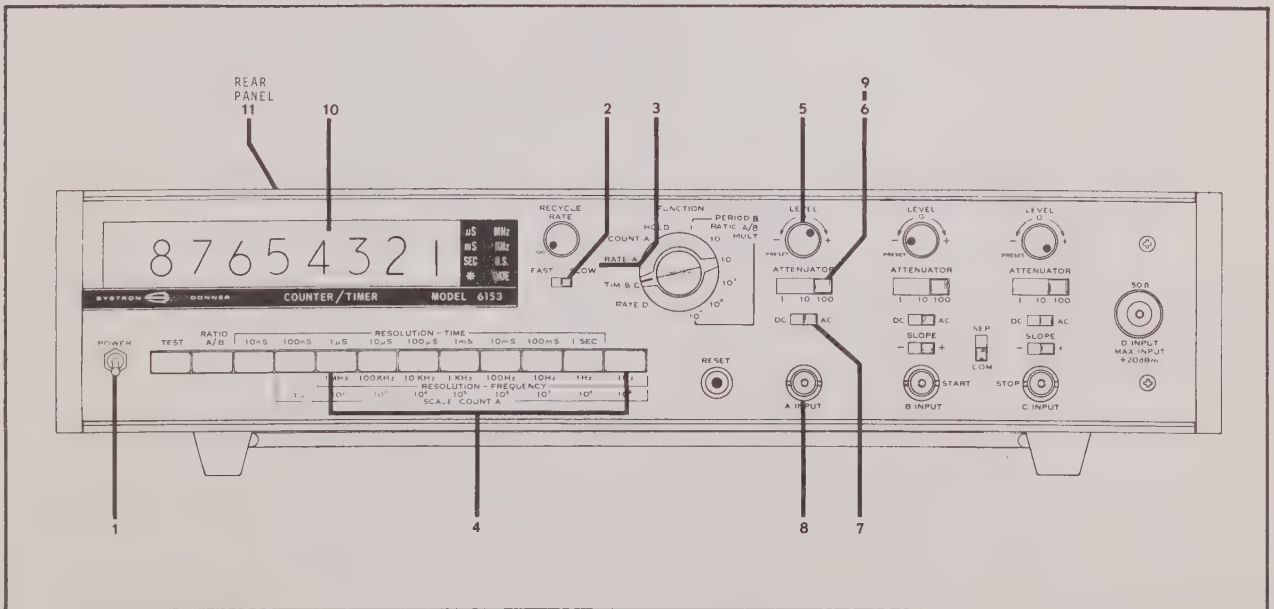


FIGURE 3.13 FREQUENCY MEASUREMENT - RATE A.

Table 3.2 TEST-RATE A/RATE D-Numerical Display  
( $\pm 1$  Count) and Measurement Units

| RESOLUTION<br>(Pushbutton)                                                                                                                                                                                                                    | Decimal Location |             | Measurement |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------|-------------|
|                                                                                                                                                                                                                                               | RATE A           | RATE D      |             |
| 1 MHz                                                                                                                                                                                                                                         | 00000100(.)      | 00002560(.) | MHz         |
| 100 kHz                                                                                                                                                                                                                                       | 0000100.0        | 0002560.0   | MHz         |
| 10 kHz                                                                                                                                                                                                                                        | 000100.00        | 002560.00   | MHz         |
| 1 kHz                                                                                                                                                                                                                                         | 00100000(.)      | 02560000(.) | kHz         |
| 100 Hz                                                                                                                                                                                                                                        | 0100000.0        | 2560000.0   | kHz         |
| 10 Hz                                                                                                                                                                                                                                         | 100000.00        | 560000.00   | kHz         |
| 1 Hz                                                                                                                                                                                                                                          | *(1)00000.000    | *60000.000  | kHz         |
| 0.1 Hz                                                                                                                                                                                                                                        | *(1)(0)0000.0000 | *0000.0000  | kHz         |
| <p style="text-align: right;">* Most Significant Digit(s)<br/>off Scale</p> <p>(If the 10 ns or 100 ns pushbuttons are pressed, an asterisk<br/>will appear in the Annunciator Display indicating an unallow-<br/>able switch condition.)</p> |                  |             |             |



Table 3.3 TEST-PERIOD/MULT. PERIOD-Numerical  
Display ( $\pm 1$  Count) and Measurement Units

| Period $\times 1$          | Period $\times 10$         | Period $\times 10^2$       | Period $\times 10^3$       | Period $\times 10^4$       | Period $\times 10^5$       |
|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| 000000.10<br>$\mu\text{s}$ | 00000.100<br>$\mu\text{s}$ | 0000.1000<br>$\mu\text{s}$ | 000.10000<br>$\mu\text{s}$ | 00.100000<br>$\mu\text{s}$ | 0.1000000<br>$\mu\text{s}$ |

Readings are independent of RESOLUTION pushbutton settings when in TEST mode.

NOTE

*The above readings apply only when 10 ns resolution option is provided; otherwise, all readings are reduced by one decade.*

Table 3.4 TEST-RATIO/MULT. RATIO-  
Numerical Display ( $\pm 1$  Count).

| FUNCTION (Switch)   | Decimal Location |
|---------------------|------------------|
| RATIO $\times 1$    | 00000010(.)      |
| RATIO $\times 10$   | 0000010.0        |
| RATIO $\times 10^2$ | 000010.00        |
| RATIO $\times 10^3$ | 00010.000        |
| RATIO $\times 10^4$ | 0010.0000        |
| RATIO $\times 10^5$ | 010.00000        |

- 6) Set the "A" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.
- 7) Set "A" INPUT DC-AC switch to the AC position.
- 8) Connect DC to 200 MHz signal into the "A" INPUT.
- 9) Decrease "A" INPUT ATTENUATOR switch to a setting which ensures stable counting.
- 10) Read frequency directly from display. Compare with data contained in Table 3.5.
- 11) Set STORAGE ON/OFF switch (Rear Panel) for desired readout mode.

### 3.7 200 MHz to 3 GHz-FREQUENCY MEASUREMENT-RATE D (Figure 3.14)

- 1) Turn instrument POWER switch to the ON position.
- 2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 3) Turn the FUNCTION switch to the RATE D position.
- 4) Press desired RESOLUTION pushbutton (1 MHz to 0.1 Hz). Check to be certain that TEST pushbutton is deactivated.
- 5) Connect 200 MHz to 3 GHz signal into the "D" INPUT.
- 6) Read frequency directly from display. Compare with data contained in Table 3.5.
- 7) Set STORAGE ON/OFF switch (Rear Panel) for desired readout mode.

### 3.8 DC TO 10 MHz-PERIOD/MULT. PERIOD MEASUREMENT (Figure 3.15)

- 1) Turn instrument POWER switch to the ON position.
- 2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 3) Turn the FUNCTION switch to the desired position (PERIOD x 1 to PERIOD x  $10^5$ ).
- 4) Press desired RESOLUTION pushbutton (10 ns to 1 sec.). Check to be certain that TEST pushbutton is deactivated.
- 5) Set SEPARate/COMMON switch to the SEPARate position.
- 6) Turn the "B" INPUT LEVEL control to the PRESET position.

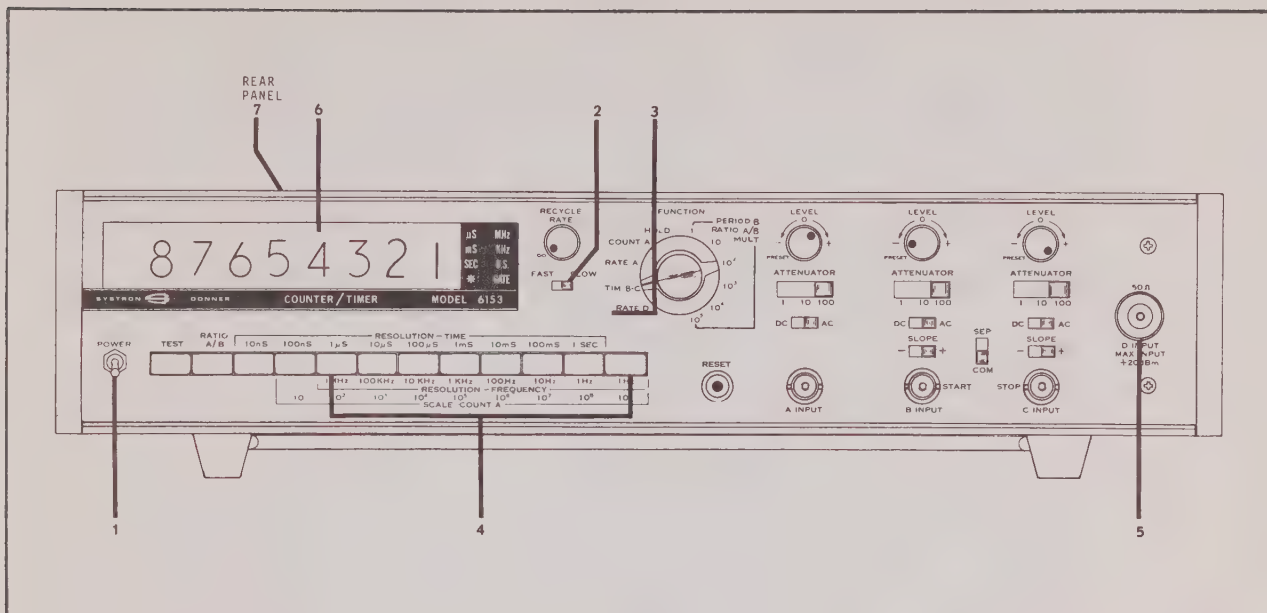


FIGURE 3.14 FREQUENCY MEASUREMENT - RATE D.

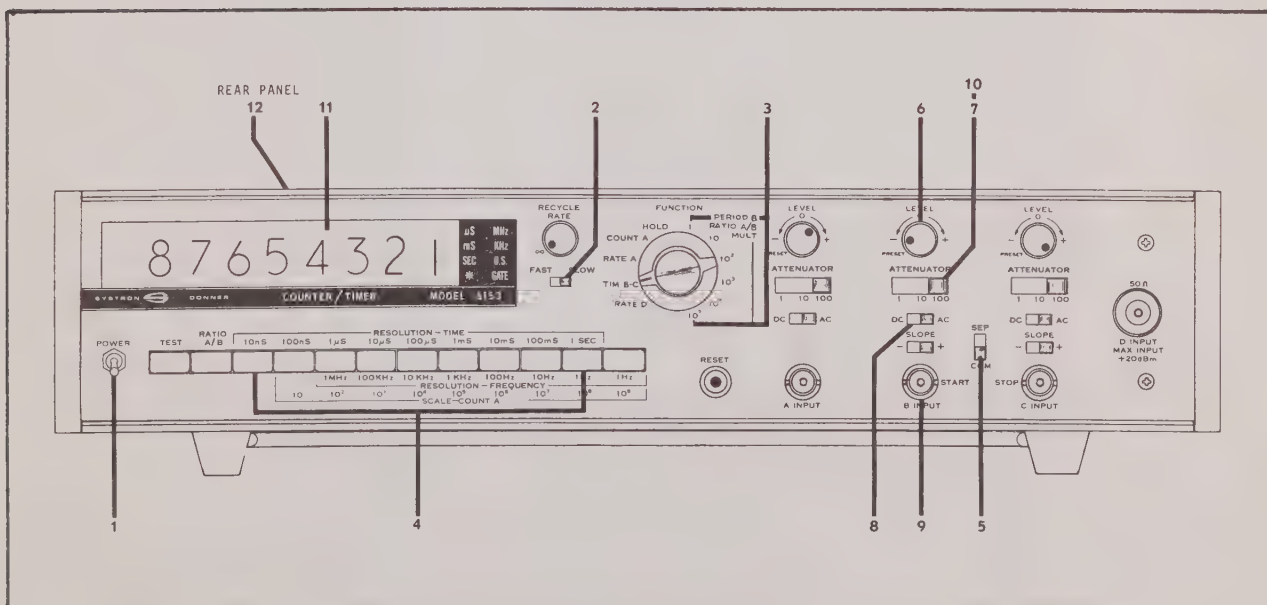


FIGURE 3.15 PERIOD/MULTIPLE PERIOD MEASUREMENT.

Table 3.5 RATE A/RATE D-Decimal Location and Measurement Units.

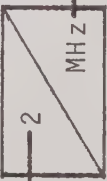
| Digit Position                                                                                                                                                     | *MSD<br>(8) | (7)      | (6)      | (5)      | (4)      | (3)      | (2)      | **LSD<br>(1) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------|----------|----------|----------|----------|----------|--------------|
| Decimal Position                                                                                                                                                   | (7)         | (6)      | (5)      | (4)      | (3)      | (2)      | (1)      | (0) No Light |
| RESOLUTION (Pushbutton)                                                                                                                                            | 1 MHz       | 100 kHz  | 10 kHz   | 1 kHz    | 100 Hz   | 10 Hz    | 1 Hz     | 0.1 Hz       |
| D.L.<br>M.U.                                                                                                                                                       | 0<br>MHz    | 1<br>MHz | 2<br>MHz | 0<br>kHz | 1<br>kHz | 2<br>kHz | 3<br>kHz | 4<br>kHz     |
| <p>TYPICAL</p>  <p>* Most Significant Digit<br/>** Least Significant Digit</p> |             |          |          |          |          |          |          |              |

Table 3.6 PERIOD/MULT. PERIOD-Decimal Location and Measurement Units.

| Digit Position                                                                                                                                                                                                       | *MSD<br>(8)  | (7)          | (6)          | (5)          | (4)          | (3)          | (2)     | (1)     | **LSD<br>(1) |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|---------|---------|--------------|
| Decimal Position                                                                                                                                                                                                     | (7)          | (6)          | (5)          | (4)          | (3)          | (2)          | (1)     | (0)     | No Light     |
| RESOLUTION (Pushbuttons)                                                                                                                                                                                             |              |              |              |              |              |              |         |         |              |
|                                                                                                                                                                                                                      | 10ns         | 100ns        | 1 $\mu$ s    | 10 $\mu$ s   | 100 $\mu$ s  | 1ms          | 10ms    | 100ms   | 1s           |
| PERIOD $\times 1$                                                                                                                                                                                                    | 2<br>$\mu$ s | 1<br>$\mu$ s | 0<br>$\mu$ s | 2<br>ms      | 1<br>ms      | 0<br>ms      | 2<br>s  | 1<br>s  | 0<br>s       |
| PERIOD $\times 10$                                                                                                                                                                                                   | 3<br>$\mu$ s | 2<br>$\mu$ s | 1<br>$\mu$ s | 0<br>$\mu$ s | 2<br>ms      | 1<br>ms      | 0<br>ms | 2<br>s  | 1<br>s       |
| PERIOD $\times 10^2$                                                                                                                                                                                                 | 4<br>$\mu$ s | 3<br>$\mu$ s | 2<br>$\mu$ s | 1<br>$\mu$ s | 0<br>$\mu$ s | 2<br>ms      | 1<br>ms | 0<br>ms | 2<br>s       |
| PERIOD $\times 10^3$                                                                                                                                                                                                 | 5<br>$\mu$ s | 4<br>$\mu$ s | 3<br>$\mu$ s | 2<br>$\mu$ s | 1<br>$\mu$ s | 0<br>$\mu$ s | 2<br>ms | 1<br>ms | 3<br>s       |
| Period $\times 10^4$                                                                                                                                                                                                 | 6<br>$\mu$ s | 5<br>$\mu$ s | 4<br>$\mu$ s | 3<br>$\mu$ s | 2<br>$\mu$ s | 1<br>$\mu$ s | 3<br>ms | 2<br>ms | 4<br>s       |
| Period $\times 10^5$                                                                                                                                                                                                 | 7<br>$\mu$ s | 6<br>$\mu$ s | 5<br>$\mu$ s | 4<br>$\mu$ s | 3<br>$\mu$ s | 2<br>$\mu$ s | 4<br>ms | 3<br>ms | 5<br>s       |
| <div> <div> TYPICAL<br/>3<br/>Decimal Location (From 0) </div> <div> 3<br/><math>\mu</math>s<br/>Measurement Units (Annunciator) </div> </div> <div> * Most Significant Digit<br/> ** Least Significant Digit </div> |              |              |              |              |              |              |         |         |              |



- 7) Set the "B" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.
- 8) Set "B" INPUT DC-AC switch to the AC position.
- 9) Connect DC to 10 MHz signal into the "B" INPUT.
- 10) Decrease "B" INPUT ATTENUATOR switch to a setting which ensures stable counting.
- 11) Read period directly from display. Compare with data contained in Table 3.6.
- 12) Set STORAGE ON/OFF switch (Rear Panel) for desired read-out mode.

### 3.9 DC TO 200 MHz-RATIO/MULT. RATIO MEASUREMENT (Figure 3.16)

- 1) Turn instrument POWER switch to the ON position.
- 2) Set RECYCLE RATE (FAST/SLOW) to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 3) Turn the FUNCTION switch to the desired position (RATIO A/B  $\times 1$  to  $\times 10^5$ ).
- 4) Press the RATIO A/B pushbutton. Check to be certain that TEST pushbutton is deactivated.
- 5) Turn the "A" INPUT LEVEL control to the PRESET position.
- 6) Set the "A" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.
- 7) Set the "A" INPUT DC-AC switch to the AC position.
- 8) Connect DC to 200 MHz (Numerator) signal into the "A" INPUT.
- 9) Turn the "B" INPUT LEVEL control to the PRESET position.
- 10) Set the "B" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.
- 11) Set the "B" INPUT DC-AC switch to the AC position.
- 12) Connect DC to 10 MHz (Denominator) signal into the "B" INPUT.
- 13) Decrease "B" INPUT ATTENUATOR switch to a setting which causes the GATE lamp (Annunciator) to light consistently.
- 14) Decrease "A" INPUT ATTENUATOR switch to a setting which ensures stable counting.

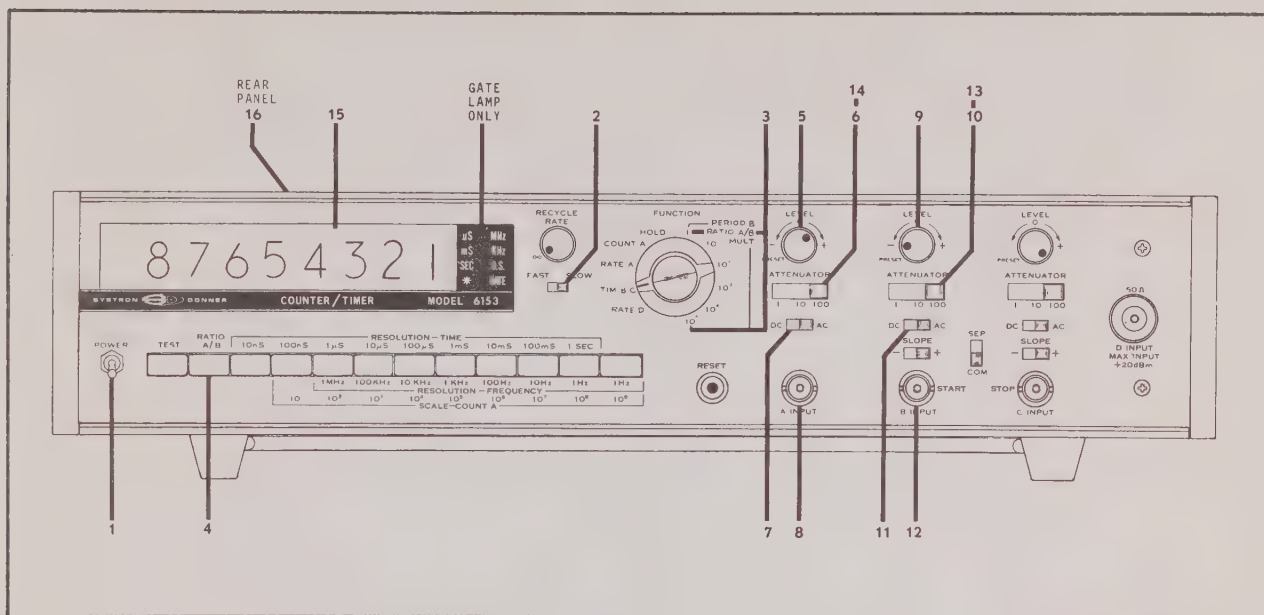


FIGURE 3.16 RATIO/MULTIPLE RATIO MEASUREMENT.

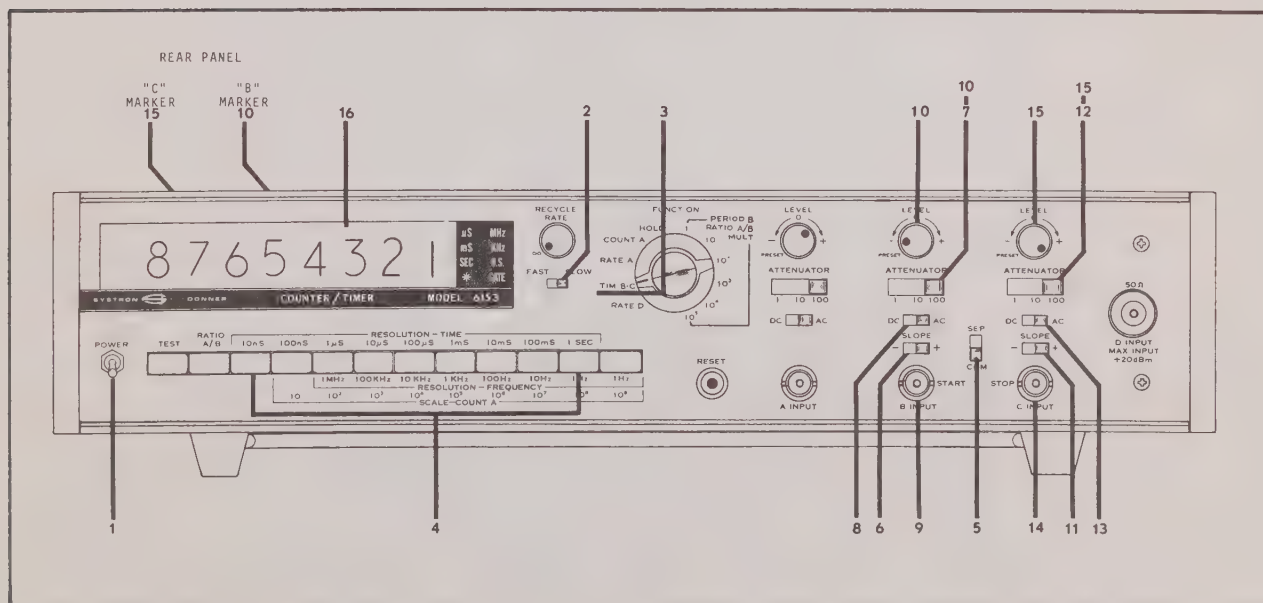


FIGURE 3.17 TIME INTERVAL MEASUREMENT.

Table 3.7 RATIO/MULTIPLE RATIO - Decimal Location

| Digit Position                    | *MSD<br>(8) | (7) | (6) | (5) | (4) | (3) | (2) | (1) | **LSD<br>(1) |
|-----------------------------------|-------------|-----|-----|-----|-----|-----|-----|-----|--------------|
| Decimal Position                  |             |     |     |     |     |     |     |     |              |
| Resolution (Pushbutton) RATIO A/B |             |     |     |     |     |     |     |     |              |
| D.L. M.U.                         |             |     |     |     |     |     |     |     |              |

TYPICAL

-1  
 (none)

Measurement Units  
(Annunciator)

\*Most Significant Digit  
\*\*Least Significant Digit

- 15) Read ratio directly from display. Compare with data contained in Table 3.7.
- 16) Set STORAGE ON/OFF switch (Rear Panel) for desired read-out mode.

### 3.10 100 ns to $10^8$ SECONDS-TIME INTERVAL MEASUREMENT (Figure 3.17)

- 1) Turn instrument POWER switch to the ON position.
- 2) Set RECYCLE RATE (FAST/SLOW) switch to the SLOW position. Adjust RECYCLE RATE potentiometer for ease of reading.
- 3) Turn the FUNCTION switch to the TIM B-C position.
- 4) Press desired RESOLUTION pushbutton (10 ns to 1 sec). Check to be certain that TEST pushbutton is deactivated.
- 5) Set SEParate/COMMon switch as follows:
  - a) When measuring the time interval between two points on the same waveform, set the SEParate/COMMon switch to the COMMon position and use the "B" INPUT only.
  - b) When the time interval between two points on separate waveforms, or between two pulses from separate sources is measured, set to the SEParate position; then, use the "B" INPUT for Start signals and the "C" INPUT for Stop signals.
- 6) Set "B" INPUT SLOPE switch to (+) or (-) depending on polarity of input signals.
- 7) Set "B" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.
- 8) Set "B" INPUT DC-AC switch for the proper coupling.
- 9) Connect the input Start or Start/Stop signals to the "B" INPUT connector.
- 10) Adjust the "B" INPUT LEVEL and ATTENUATOR controls to produce consistent triggering. Utilize the rear panel "B" MARKER output signal for oscilloscope synchronization.
- 11) Set "C" INPUT SLOPE switch to (+) or (-) depending on polarity of input signals.
- 12) Set "C" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.
- 13) Set "C" INPUT DC-AC switch for the proper coupling.
- 14) Connect the input Stop signals to the "C" INPUT connector.

Table 3.8 TIME INTERVAL-Decimal Location and Measurement Units.

| Digit Position                                         | (8)      | (7)   | (6) | (5)  | (4)   | (3) | (2)  | (1)   | (0) |
|--------------------------------------------------------|----------|-------|-----|------|-------|-----|------|-------|-----|
| Decimal Position                                       | No Light |       |     |      |       |     |      |       |     |
| RESOLUTION (Pushbutton)                                | 10ns     | 100ns | 1μs | 10μs | 100μs | 1ms | 10ms | 100ms | 1s  |
| D.L.                                                   | 2        | 1     | 0   | 2    | 1     | 0   | 2    | 1     | 0   |
| M.U.                                                   | μs       | μs    | μs  | ms   | ms    | ms  | s    | s     | s   |
| * Most Significant Digit<br>** Least Significant Digit |          |       |     |      |       |     |      |       |     |

TYPICAL

2

μs

Decimal Location (From 0)

Measurement Units (Annunciator)



- 15) Adjust the "C" INPUT LEVEL and ATTENUATOR controls to produce consistent triggering. Utilize the rear panel "C" MARKER output signal for oscilloscope synchronization.
- 16) Read time interval data directly from display. Compare with information contained in Table 3.8.

### 3.11 TOTALIZE/SCALE MEASUREMENT (Figure 3.18)

- 1) Turn instrument POWER switch to the ON position.
- 2) Turn the FUNCTION switch to the COUNT A position. Check to be certain that TEST pushbutton is deactivated.
- 3) Turn the "A" INPUT LEVEL control to the PRESET position.
- 4) Set the "A" INPUT ATTENUATOR 1, 10, 100 switch to the 100 position.
- 5) Set the "A" INPUT DC-AC switch to the AC position.
- 6) Connect count signals into the "A" INPUT.
- 7) Decrease "A" INPUT ATTENUATOR switch to a setting which ensures stable counting.
- 8) Turn the FUNCTION switch to the HOLD position.
- 9) Press the RESET pushbutton to clear the counter display.
- 10) When ready to totalize, turn the FUNCTION switch to the COUNT A position; the totalize routine will commence.
- 11) When ready to stop, turn the FUNCTION switch to the HOLD position; the totalize routine will cease.
- 12) Read the totalized count directly from the display.
- 13) To scale an "A" INPUT frequency, press desired RESOLUTION pushbutton (SCALE-COUNT A, 10 to  $10^9$ ); and, couple the scaled frequency from the Time Base SCALE OUTPUT BNC connector. Scale factor for the frequency division is determined by the RESOLUTION pushbutton selected.

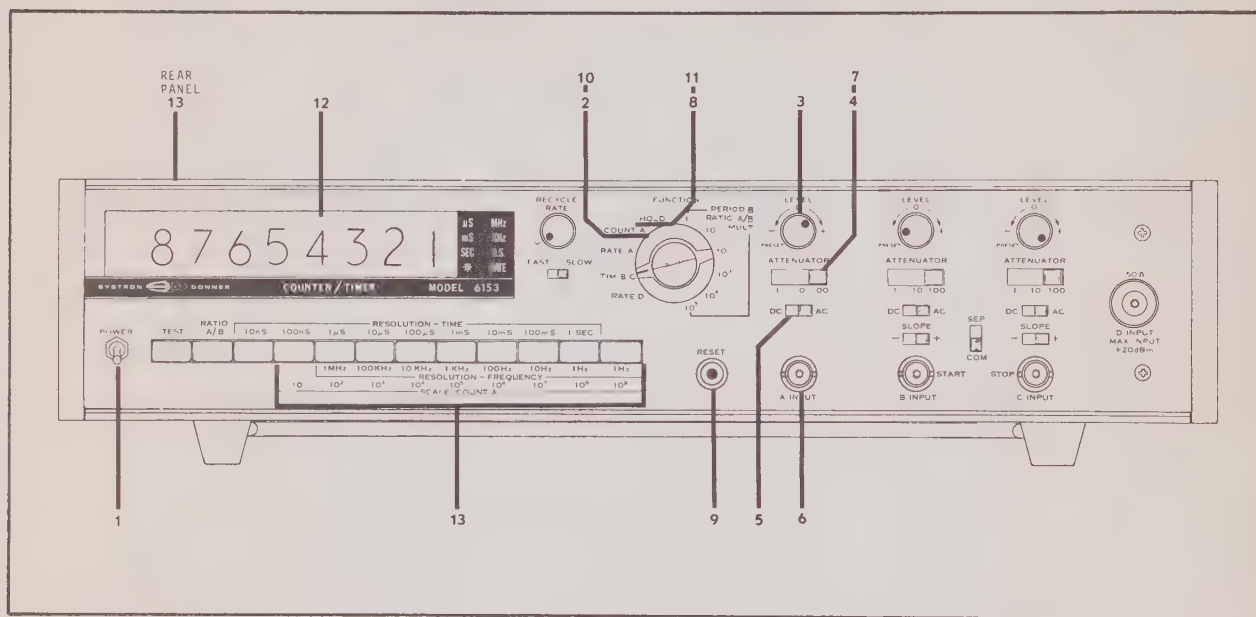


FIGURE 3.18 TOTALIZE/SCALE MEASUREMENT.

## CHAPTER 4

### PRINCIPLES OF OPERATION

#### 4.1 INTRODUCTION

The Model 6153-50 is an integrated circuit, multi-function counter that measures the frequency and period of a signal; the time interval between two points on a signal, or on two related or unrelated signals; the ratio of two frequencies; or the total number of signal pulses. Measurements are classified under the two basic functions of Frequency and Period. Other operating modes are modifications of these two functions. The measuring techniques compare the frequency or period of an unknown signal to a time base derived from a reference frequency.

Figure 4.1 is a functional block diagram of the instrument. The system consists of front panel controls, input amplifier-shapers, function select logic, function control logic, time base, oscillator reference, decade counters, readout unit, and power supply. The FUNCTION switch on the front panel connects the appropriate circuit for the particular measuring function through the function select logic. The RESOLUTION switch selects a time base reference signal. The combined positions of the two switches determine the proper decimal point placement and measurement unit indication in the readout.

When an unknown signal is connected to the instrument, the input amplifier-shaper converts the signal into a rectangular waveform. In Frequency mode, the rectangular waveform is converted into counting pulses that are directed to the decade counters when the count gate is opened by the selected time base. In Period mode, the rectangular waveform opens the count gate for one period of the unknown signal. During this period the decade counters count the number of pulses from the time base.

In either mode, the serial data is converted into BCD format by the decade counters. Then the BCD data is decoded into decimal outputs by the decimal decoders. The decimal decoders drive eight decimal readout tubes that indicate the measurement, along with measurement unit indication, and decimal point placement. Display time of the measurement, independent of gate time, is manually adjustable from 500 microseconds to 5 seconds depending on the position of the FAST/SLOW switch and the RECYCLE RATE potentiometer. The readout unit continuously displays the most recent measurement at the end of each gate time.

#### 4.2 LOGIC DEVICES

Table 4.1 indicates the typical integrated circuit devices found in this instrument.

#### 4.3 LOGIC SYMBOLS

The symbols used in this manual are standardized by MIL-STD-806B, dated February 26, 1962. Symbols used for a gate depend on whether



TABLE 4.1 TYPICAL I.C. COMPONENTS IN MODEL 6153-50

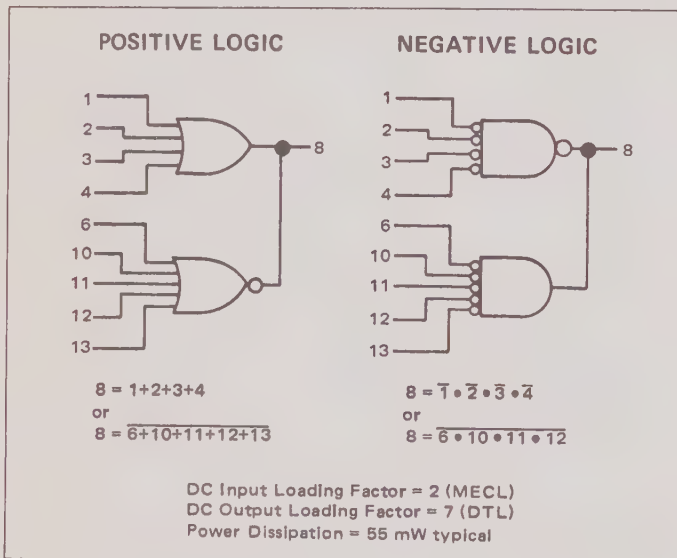
| SD PART | DESCRIPTION          | T.I.     | MOTOROLA | NATIONAL | RCA     | SIGNETICS |
|---------|----------------------|----------|----------|----------|---------|-----------|
| 19712   | Dual 4 Input Gate    | SN15830N | MC830P   |          |         |           |
| 25741   | Hex Inverter         | SN15836N | MC836P   |          |         |           |
| 19716   | Quad 2 Input Gate    | SN15846N | MC846P   |          |         |           |
| 19719   | Triple 3 Input Gate  | SN15862N | MC862P   |          |         |           |
| 25734   | Quad 2 Input Gate    |          | MC1808P  |          |         |           |
| 25753   | Quad 2 Input Buffer  |          | MC857P   |          |         |           |
| 19705   | Quad 2 Input Gate    | SN7400N  | MC7400P  | DM8000   |         |           |
| 19706   | Triple 3 Input Gate  | SN7410N  | MC7410P  | DM8010   |         |           |
| 19709   | Dual JK F.F.         | SN7473N  | MC7473P  | DM8073   |         |           |
| 25241   | Dual D F.F.          | SN7474N  | MC7474P  | DM8074   |         |           |
| 19710   | Quad Latch           | SN7475N  | MC7475P  | DM8075   |         |           |
| 25731   | Quad Latch           | SN7075N  |          |          |         |           |
| 19711   | Decade Counter       | SN7490N  | MC7490P  | DM8090   |         |           |
| 25732   | Decade Counter       | SN7090N  |          |          |         |           |
| 19707   | BCD-Dec. Decoder     | SN7441AN | MC7441P  |          |         | N7441B    |
| 25730   | BCD-Dec. Decoder     | SN7041AN |          |          |         |           |
| 25727   | Binary Counter       |          |          |          |         | N8281A    |
| 25722   | Decade Counter       |          |          |          |         | N8280A    |
| 25718   | Dual 4-1 Clock Drive |          | MC1023P  |          |         |           |
| 25719   | JK F.F.              |          | MC1027P  |          |         |           |
| 25745   | Oper. Amp.           |          |          | LM201    |         |           |
| 25729   | Oper. Amp.           |          | MC1439P  |          |         |           |
| 25725   | Trans. Array         |          |          |          | CA3046  |           |
| 25724   | Six Trans. Array     |          |          |          | CA3026  |           |
| 25702   | R.F. Amp.            |          |          |          | CA3028A |           |
| 25720   | R.F. Amp.            |          |          |          | CA3018  |           |



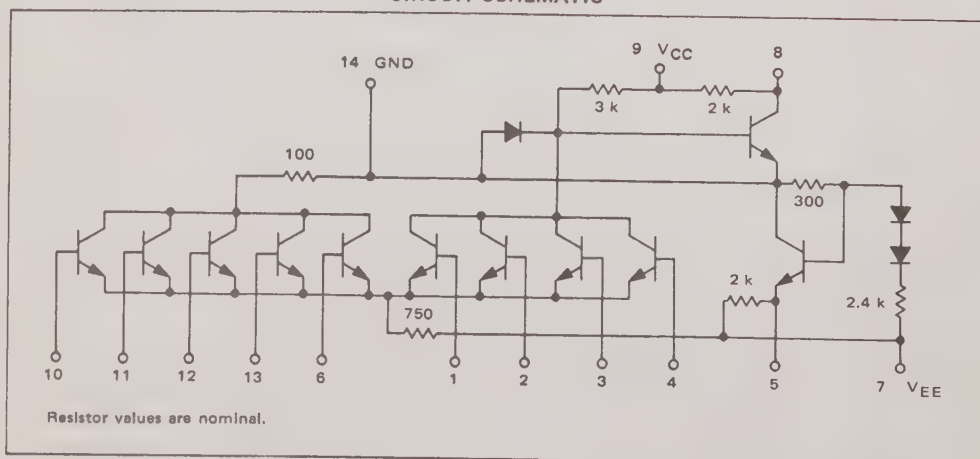
MECL-TO-SATURATED LOGIC  
TRANSLATORS

**MC1018**  
**MC1218**

Level translator intended for converting MECL signal levels to saturated logic levels. The translator will provide the positive logic OR or logic NOR function by connecting the internal bias driver output to the corresponding inputs of the differential amplifier. i.e., when pin 4 is connected to the reference bias, pin 5, pins 6, 10, 11, 12, and 13 become the inputs of a 5-input NOR gate. When pin 6 is connected to the reference bias, pin 5, pins 1, 2, 3, and 4 become the inputs of a 4-input OR gate.



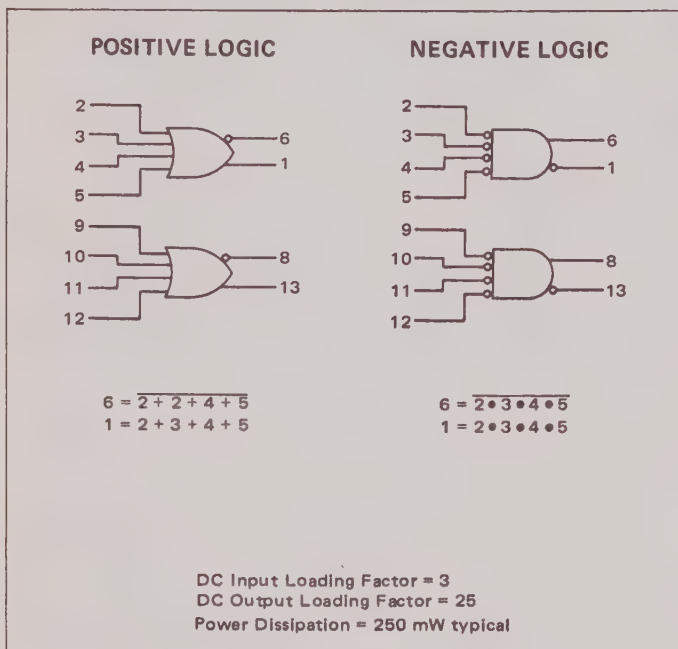
CIRCUIT SCHEMATIC



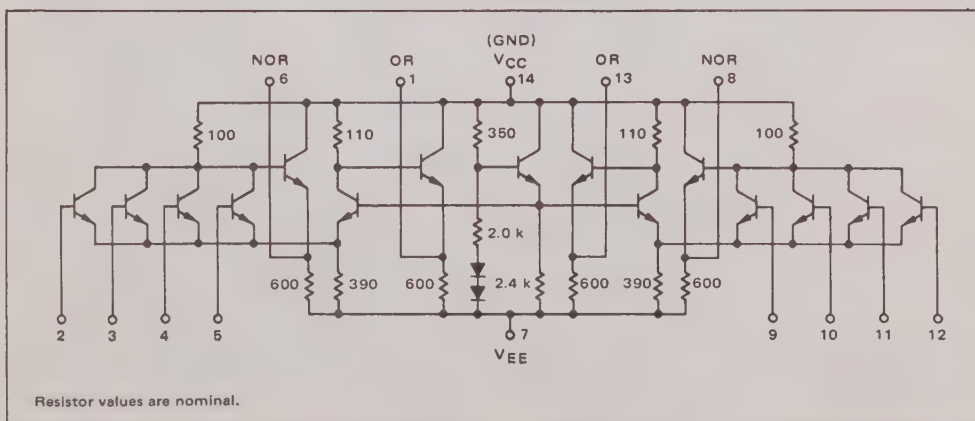
DUAL 4-INPUT  
CLOCK DRIVER  
**MC1023**

Provides simultaneous OR/NOR or AND/NAND output functions. It contains an internal bias reference insuring that the threshold point is always in the center of the transition region over the temperature range.

This circuit is designed to operate in high-speed digital computer applications as a clock driver or as a high-speed gate.



**CIRCUIT SCHEMATIC**

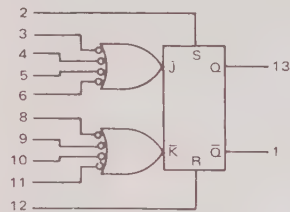


120-MHz AC-COUPLED  
J-K FLIP FLOPS

# MC1027

Designed for use at clock frequencies to 100 MHz minimum (120 MHz typical). Logic performing inputs ( $\bar{J}$  and  $\bar{K}$ ) are available, as well as dc SET and RESET inputs.

## POSITIVE LOGIC



DC Input Loading Factor = 2  
DC Output Loading Factor = 25  
Power Dissipation = 250 mW typical

- \* Any  $\bar{J}$  or  $\bar{K}$  Input, not used for  $\bar{C}_D$ .
- \*\*  $\bar{C}_D$  obtained by connecting one  $\bar{J}$  and one  $\bar{K}$  input together.

The  $\bar{J}$  and  $\bar{K}$  inputs refer to logic levels while the  $\bar{C}_D$  input refers to dynamic logic swings. The  $\bar{J}$  and  $\bar{K}$  inputs should be changed to a logical "1" only while the  $\bar{C}_D$  input is in a logic "1" state. ( $\bar{C}_D$  maximum "1" level =  $V_{CC} - 0.6$  V). Clock  $\bar{C}_D$  is obtained by tying one  $\bar{J}$  and one  $\bar{K}$  input together.

## R-S TRUTH TABLE

Pin No.

| R  | S | $Q^{n+1}$ |
|----|---|-----------|
| 12 | 2 | 13        |
| 0  | 0 | $Q^n$     |
| 0  | 1 | 1         |
| 1  | 0 | 0         |
| 1  | 1 | N.D.      |

All  $\bar{J}$ - $\bar{K}$  Inputs Are Static

## $\bar{J}_D$ - $\bar{K}_D$ TRUTH TABLE

Pin No.

| $\bar{J}_D$ | $\bar{K}_D$ | $Q^{n+1}$   |
|-------------|-------------|-------------|
| *           | *           | 13          |
| 0           | 0           | $Q^n$       |
| 0           | 1           | 0           |
| 1           | 0           | 1           |
| 1           | 1           | $\bar{Q}^n$ |

All Other  $\bar{J}$ - $\bar{K}$  Inputs And The R-S Inputs Are At a "0" Level

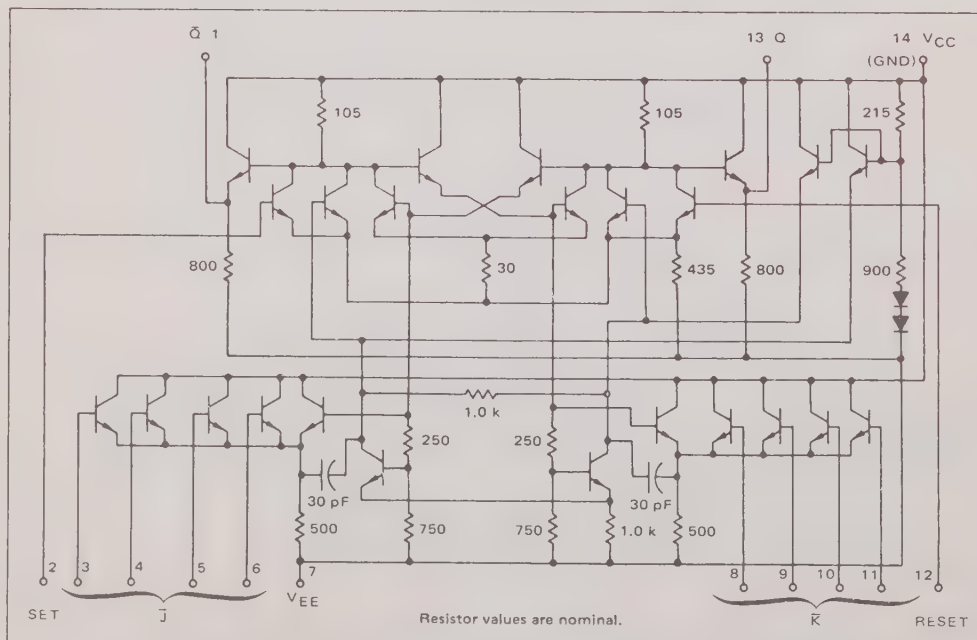
## CLOCKED $\bar{J}$ - $\bar{K}$ TRUTH TABLE

Pin No.

| $\bar{J}$ | $\bar{K}$ | $\bar{C}_D$ | $Q^{n+1}$   |
|-----------|-----------|-------------|-------------|
| *         | *         | **          | 13          |
| $\phi$    | $\phi$    | 0           | $Q^n$       |
| 0         | 0         | 1           | $\bar{Q}^n$ |
| 0         | 1         | 1           | 1           |
| 1         | 0         | 1           | 0           |
| 1         | 1         | 1           | $Q^n$       |

All Other  $\bar{J}$ - $\bar{K}$  Inputs And The R-S Inputs Are At a "0" Level

## CIRCUIT SCHEMATIC



# CIRCUIT TYPE SN7441A

## BCD-TO-DECIMAL DECODER/DRIVER

logic

| TRUTH TABLE |   |   |   |                |
|-------------|---|---|---|----------------|
| INPUT       |   |   |   | OUTPUT<br>ON : |
| D           | C | B | A |                |
| 0           | 0 | 0 | 0 | 0              |
| 0           | 0 | 0 | 1 | 1              |
| 0           | 0 | 1 | 0 | 2              |
| 0           | 0 | 1 | 1 | 3              |
| 0           | 1 | 0 | 0 | 4              |
| 0           | 1 | 0 | 1 | 5              |
| 0           | 1 | 1 | 0 | 6              |
| 0           | 1 | 1 | 1 | 7              |
| 1           | 0 | 0 | 0 | 8              |
| 1           | 0 | 0 | 1 | 9              |

‡ All other outputs are off.

### description

The SN7441A is a monolithic, BCD-to-decimal decoder incorporating high performance output transistors designed for driving gas-filled, cold-cathode indicator tubes. The BCD-to-decimal decoder consists of familiar transistor-transistor-logic (TTL) gate circuits which select one of the ten decimal output drivers. The BCD inputs are fully compatible with Series 74 logic outputs; and, in addition, physical placement of these inputs is coincidental with the BCD output of the SN7490 decade counter. The ten high-breakdown, n-p-n transistors have a maximum reverse current of 50  $\mu$ A at 55 V over the operating temperature range.

A typical application shows the SN7441A used as a gas-filled, display-indicator driver.

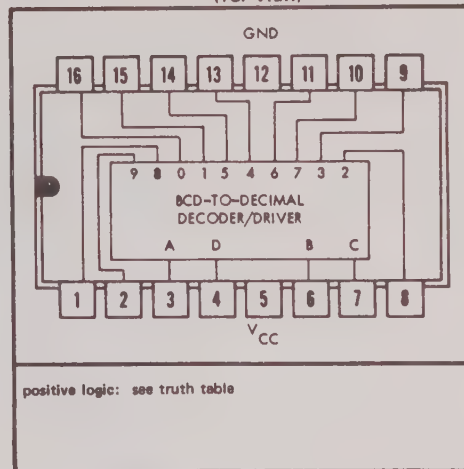
### typical application data

The SN7441A output transistors are capable of withstanding voltages and sinking current required to operate most types of gas-filled indicator tubes.

Clamping diodes have been incorporated in the outputs of this improved decoder/driver.

When these decoder/drivers are used in close proximity (on the same circuit board) with standard digital integrated circuits, care should be exercised to ensure that the impedance of the ground bus (including interconnections) is sufficiently low to absorb the normal energy levels resulting from switching the tube elements.

J OR N DUAL-IN-LINE PACKAGE  
(TOP VIEW)



positive logic: see truth table

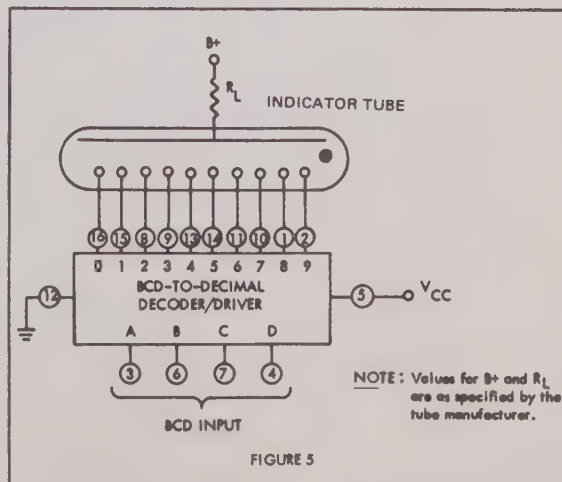


FIGURE 5

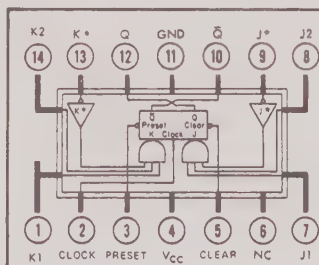
# CIRCUIT TYPES SN5470, SN7470 EDGE-TRIGGERED J-K FLIP-FLOPS

## logic

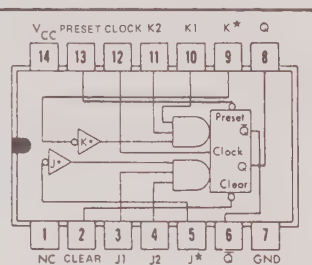
| TRUTH TABLE |           |             |
|-------------|-----------|-------------|
| $t_n$       | $t_{n+1}$ |             |
| J           | K         | Q           |
| 0           | 0         | $Q_n$       |
| 0           | 1         | 0           |
| 1           | 0         | 1           |
| 1           | 1         | $\bar{Q}_n$ |

- NOTES: 1.  $J = J_1 \cdot J_2 \cdot J^*$   
 2.  $K = K_1 \cdot K_2 \cdot K^*$   
 3.  $t_n$  = Bit time before clock pulse.  
 4.  $t_{n+1}$  = Bit time after clock pulse.  
 5. If inputs  $J^*$  or  $K^*$  are not used they must be grounded.  
 6. NC - No Internal Connection

S FLAT PACKAGE  
(TOP VIEW)



J OR N DUAL-IN-LINE PACKAGE  
(TOP VIEW)



positive logic: Low input to preset sets Q to logical 1  
 Low input to clear sets Q to logical 0  
 Preset or clear function can occur only when clock input is low.

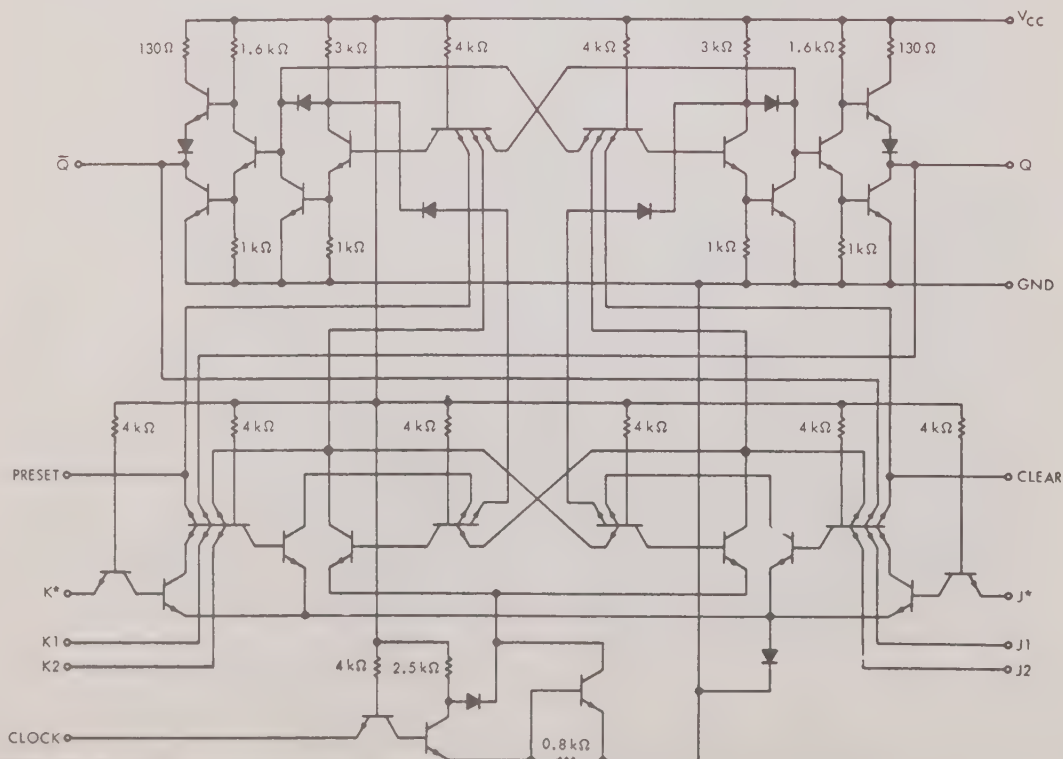
## description

These monolithic, edge-triggered J-K flip-flops feature gated inputs, direct clear and preset inputs, and complementary Q and  $\bar{Q}$  outputs. Input information is transferred to the outputs on the positive edge of the clock pulse.

Direct-coupled clock triggering occurs at a specific voltage level of the clock pulse, and after the clock input threshold voltage has been passed, the gated inputs are locked out.

These flip-flops are ideally suited for medium- to high-speed applications and can result in a significant saving in system power dissipation and package count where input gating is required.

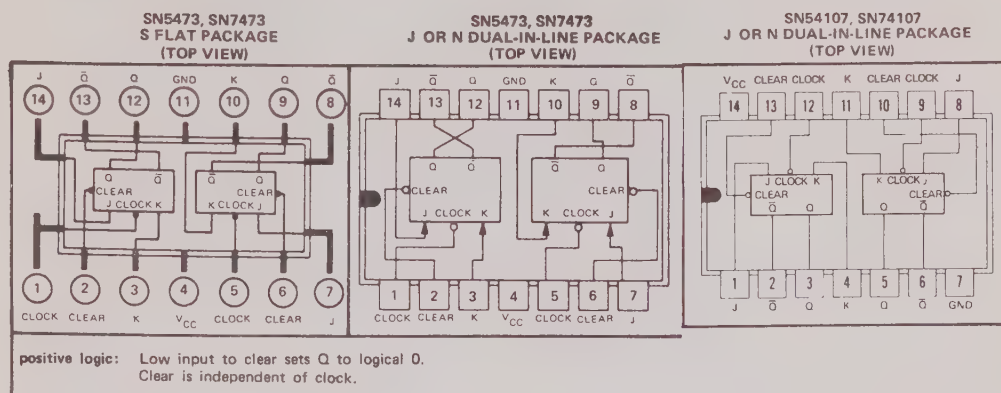
## schematic





## CIRCUIT TYPES SN5473

### DUAL J-K MASTER-SLAVE FLIP-FLOPS



#### description

These J-K flip-flops are based on the master-slave principle. Inputs to the master section are controlled by the clock pulse. The clock pulse also regulates the state of the coupling transistors which connect the master and slave sections. The sequence of operation is as follows: (See waveform on page 2-26)

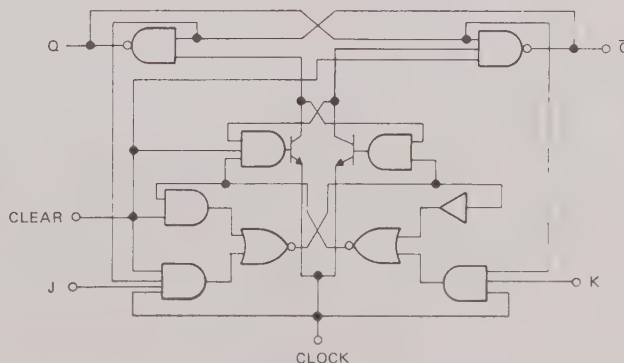
1. Isolate slave from master
2. Enter information from J and K inputs to master
3. Disable J and K inputs
4. Transfer information from master to slave.

#### logic

| TRUTH TABLE<br>(Each Flip-Flop) |   |             |
|---------------------------------|---|-------------|
| $t_n$                           |   | $t_{n+1}$   |
| J                               | K | Q           |
| 0                               | 0 | $Q_n$       |
| 0                               | 1 | 0           |
| 1                               | 0 | 1           |
| 1                               | 1 | $\bar{Q}_n$ |

NOTES: 1.  $t_n$  = Bit time before clock pulse.  
2.  $t_{n+1}$  = Bit time after clock pulse.

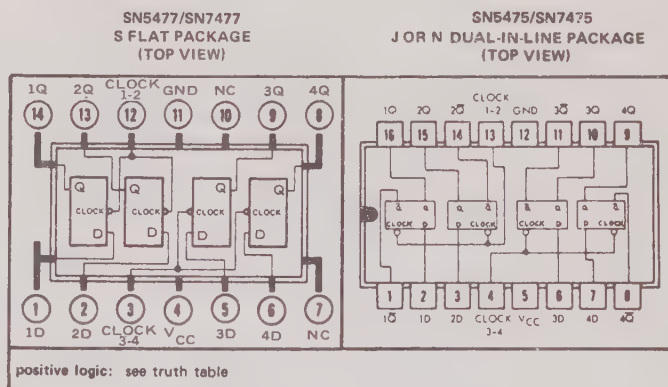
#### functional block diagram (each flip-flop)



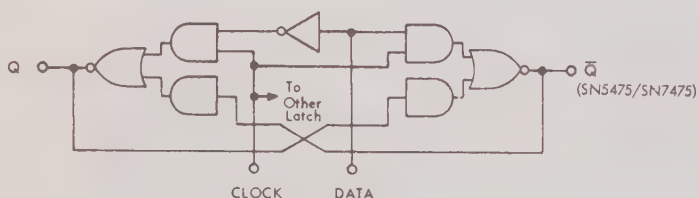
# CIRCUIT TYPES SN5475, 4-BIT BISTABLE LATCHES

logic

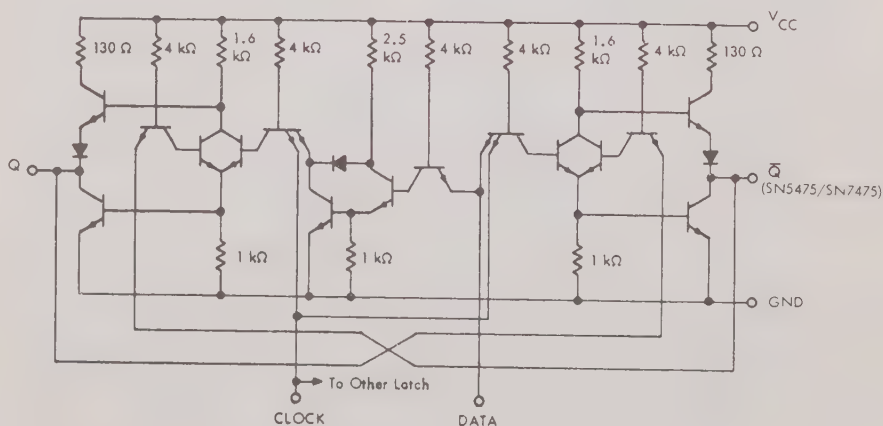
| TRUTH TABLE<br>(Each Latch) |           |
|-----------------------------|-----------|
| $t_n$                       | $t_{n+1}$ |
| D                           | Q         |
| 1                           | 1         |
| 0                           | 0         |



functional block diagram (each latch)



schematic (each latch)



description

These latches are ideally suited for use as temporary storage for binary information between processing units and input/output or indicator units. Information present at a data (D) input is transferred to the Q output when the clock is high, and the Q output will follow the data input as long as the clock remains high. When the clock goes low, the information (that was present at the data input at the time the transition occurred) is retained at the Q output until the clock is permitted to go high.

# CIRCUIT TYPES SN5490, SN7490 DECADE COUNTERS

## TRUTH TABLES

| BCD COUNT SEQUENCE<br>(See Note 1) |        |   |   |   |
|------------------------------------|--------|---|---|---|
| COUNT                              | OUTPUT |   |   |   |
|                                    | D      | C | B | A |
| 0                                  | 0      | 0 | 0 | 0 |
| 1                                  | 0      | 0 | 0 | 1 |
| 2                                  | 0      | 0 | 1 | 0 |
| 3                                  | 0      | 0 | 1 | 1 |
| 4                                  | 0      | 1 | 0 | 0 |
| 5                                  | 0      | 1 | 0 | 1 |
| 6                                  | 0      | 1 | 1 | 0 |
| 7                                  | 0      | 1 | 1 | 1 |
| 8                                  | 1      | 0 | 0 | 0 |
| 9                                  | 1      | 0 | 0 | 1 |

| RESET/COUNT (See Note 2) |                   |                   |                   |         |
|--------------------------|-------------------|-------------------|-------------------|---------|
| RESET INPUTS             |                   |                   |                   | OUTPUT  |
| R <sub>0(1)</sub>        | R <sub>0(2)</sub> | R <sub>9(1)</sub> | R <sub>9(2)</sub> | D C B A |
| 1                        | 1                 | 0                 | X                 | 0 0 0 0 |
| 1                        | 1                 | X                 | 0                 | 0 0 0 0 |
| X                        | X                 | 1                 | 1                 | 1 0 0 1 |
| X                        | 0                 | X                 | 0                 | COUNT   |
| 0                        | X                 | 0                 | X                 | COUNT   |
| 0                        | X                 | X                 | 0                 | COUNT   |
| X                        | 0                 | 0                 | X                 | COUNT   |

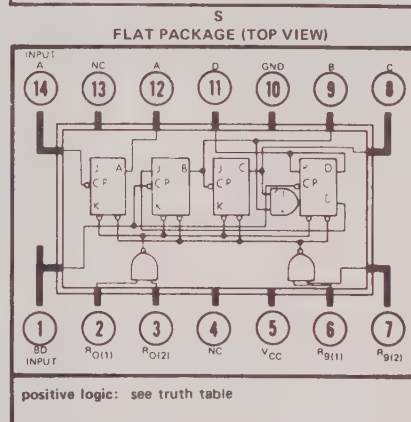
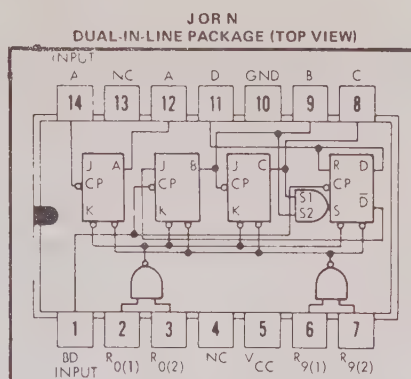
NC—No Internal Connection

- NOTES: 1. Output A connected to input BD for BCD count.  
2. X indicates that either a logical 1 or a logical 0 may be present.

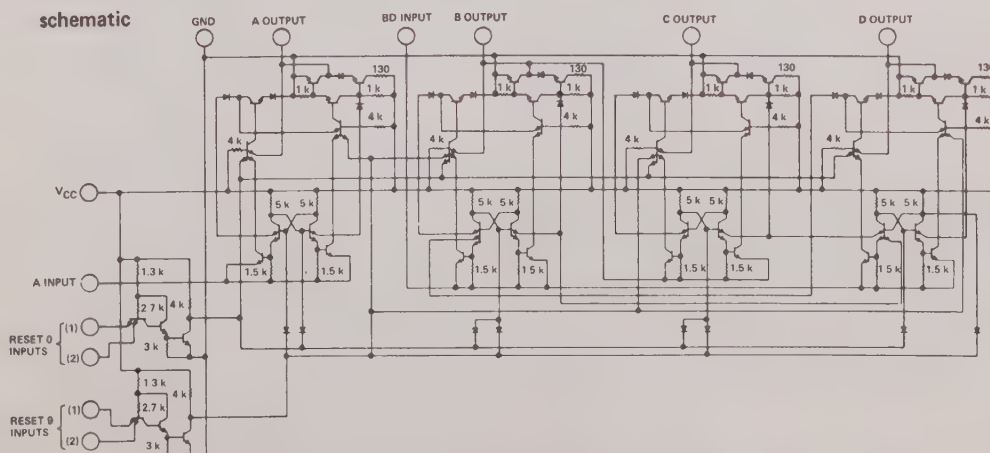
## description and typical count configurations

These high-speed, monolithic decade counters consist of four dual-rank, master-slave flip-flops internally interconnected to provide a divide-by-two counter and a divide-by-five counter. Gated direct reset lines are provided to inhibit count inputs and return all outputs to logical zero or to a binary coded decimal (BCD) count of 9. As the output from flip-flop A is not internally connected to the succeeding stages, the count may be separated in three independent count modes:

1. When used as a binary coded decimal decade counter, the BD input must be externally connected to the A output. The A input receives the incoming count, and a count sequence is obtained in accordance with the BCD count sequence truth table shown above. In addition to a conventional zero reset, inputs are provided to reset a BCD count for nine's complement decimal applications.
2. If a symmetrical divide-by-ten count is desired for frequency synthesizers or other applications requiring division of a binary count by a power of ten, the D output must be externally connected to the A input. The input count is then applied at the BD input and a divide-by-ten square wave is obtained at output A.
3. For operation as a divide-by-two counter and a divide-by-five counter, no external interconnections are required. Flip-flop A is used as a binary element for the divide-by-two function. The BD input is used to obtain binary divide-by-five operation at the B, C, and D outputs. In this mode, the two counters operate independently; however, all four flip-flops are reset simultaneously.

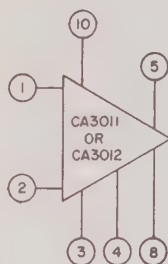


## schematic

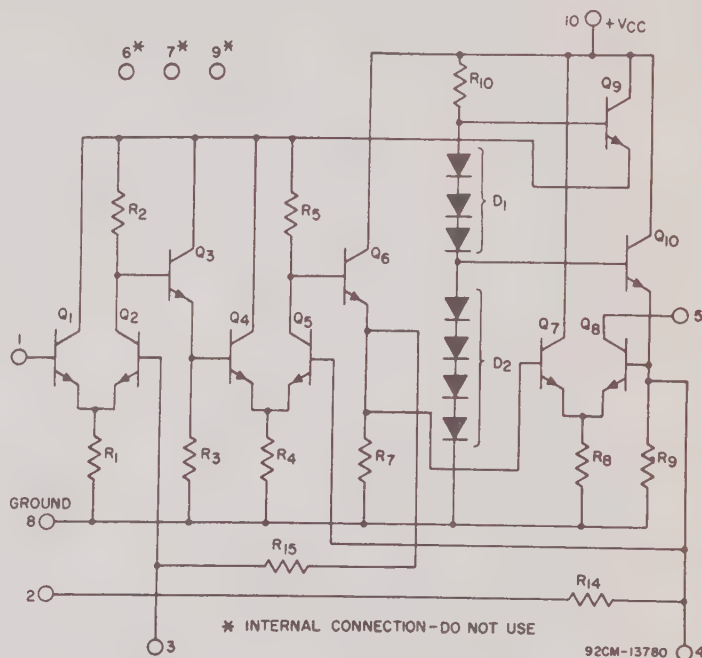


# CA3011 CA3012

## Wide-Band Amplifiers



SCHEMATIC DIAGRAM FOR CA3011 AND CA3012

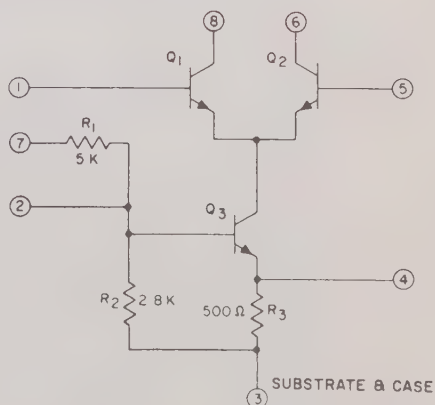


# CA3028A CA3028B

## Differential/Cascode Amplifiers

The CA3028A and CA3028B are differential/cascode amplifiers designed for use in communications and industrial equipment operating at frequencies from dc to 120 MHz.

The CA3028B is like the CA3028A but is capable of premium performance particularly in critical dc and differential amplifier applications requiring tight controls for input offset voltage, input offset current, and input bias current.



Schematic diagram for CA3028A

the element is activated by a relatively high, or relatively low signal (see Figure 4.2). Each terminal of a device can have one of two states: "zero" or "one". Zero is the reference (inactive) state, and one is the significant (active) state. The small circle at the point where a signal line joins the symbol indicates that the line's active state is the relatively low signal. The absence of such a circle indicates that the line's active state is the relatively high signal state. For positive logic, the symbol has no circles at the input and a circle at the output. Thus, inputs are normally low when inactive, and high when activated. The output is normally high, and goes low when the gate is activated by a high signal at the input. Also, the element is performing the OR function, as indicated by the shape of the symbol, because a change of state in any one of the inputs causes a change of state in the output. For negative logic, the symbol has circles on its inputs and none on the output. All inputs must be low or in their active state before the output changes; thus, this symbol indicates the AND function.

Symbols and truth tables for logic used in this instrument are shown in Figure 4.3.

#### 4.4 CIRCUIT DESCRIPTIONS

##### 4.4.1 200 MHz Amplifier Board - A16 (Schematic 39320)

The printed circuit (PC) board consists of three distinct, inter-dependent operating circuits:

The Attenuator section is front panel switch-controlled and remotely programmed to present the Amplifier section a signal which is equal to, 1/10 of, or, 1/100 of the input signal, while maintaining a constant 1 MΩ load on the input connector. The DC-AC remote selection network is also incorporated into the Attenuator section.

The Amplifier section converts the high-impedance, single-ended input to a low-impedance, differential output of sufficient amplitude to activate the emitter-coupled output logic.

The Output Shaper section imparts a uniform rise time to the signals from the amplifier section for use by the function control logic.

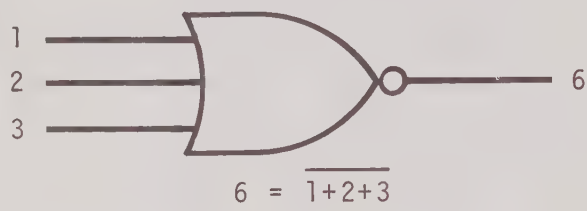
##### 1) ATTENUATOR

The signal from the input connector is presented to the dc blocking capacitor C16. If dc operation is desired, DC-AC relay L4 is energized, shorting capacitor C16. If an attenuation ratio of X1 has been selected, relay L1 is energized, connecting resistor R1 and capacitor C1 to frequency compensation network L3, R4, C14 and the input BNC. Relays L2 and L3 are open, presenting the Amplifier section with, essentially, the input signal. If the input signal exceeds ±1.0 volt, diode CR4 or CR5 will conduct, protecting the Amplifier section from damage.

If an attenuation ratio of X10 is selected, relay L2 is closed and relays L1 and L3 are open. Relay L2 connects



POSITIVE LOGIC



NEGATIVE LOGIC

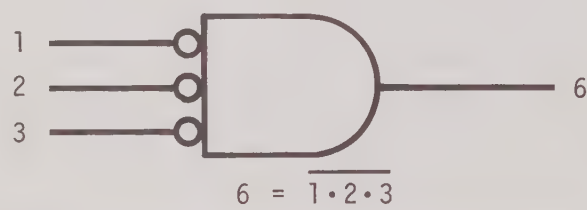


FIGURE 4.2 LOGIC SYMBOLS

| A | B | C |
|---|---|---|
| H | H | L |
| H | L | H |
| L | H | H |
| L | L | H |

NAND



$$\overline{A \cdot B} = C$$

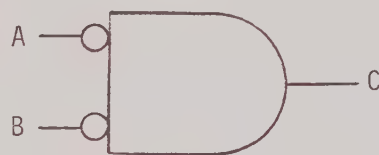
INV. OR



$$\overline{A + B} = C$$

| A | B | C |
|---|---|---|
| H | H | L |
| H | L | L |
| L | H | L |
| L | L | H |

INV. AND



$$\overline{A \cdot B} = C$$

NOR



$$\overline{A + B} = C$$

| A | B | C |
|---|---|---|
| H | H | H |
| H | L | L |
| L | H | L |
| L | L | L |

AND



$$A \cdot B = C$$

INV. NOR



$$\overline{\overline{A + B}} = C$$

| A | B | C |
|---|---|---|
| H | H | H |
| H | L | H |
| L | H | H |
| L | L | L |

INV. NAND



$$\overline{\overline{A \cdot B}} = C$$

OR



$$A + B = C$$

FIGURE 4.3 MODEL 6153-50 CIRCUIT LOGIC SYMBOLS

| A | B | C |
|---|---|---|
| H | H | L |
| H | L | H |
| L | H | H |
| L | L | L |

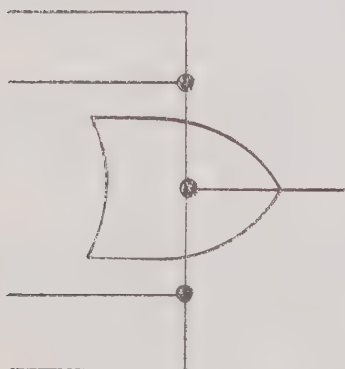
# EXCLUSIVE OR



$$(A + B) \cdot (\overline{A \cdot B}) = C$$

$$(A \cdot \overline{B}) + (\overline{A} \cdot B) = C$$

## DOT OR



## DOT AND

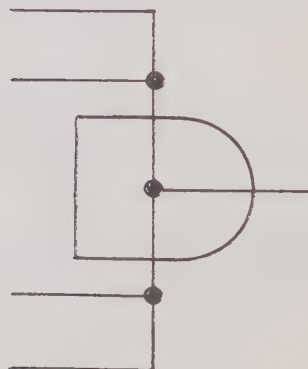


FIGURE 4.3 MODEL 6153-50 CIRCUIT LOGIC SYMBOLS (CONT'D)

the low end of resistor R10 to resistor R1 and capacitor C1. Resistors R7, R9 and R10 form a 100:1 voltage divider, presenting the Amplifier section with 1/100 of the input signal.

## 2) AMPLIFIER

Field effect transistor (FET) Q1A provides impedance matching between the input attenuator circuit and one side of differential amplifier Q3, Q4. It also serves to increase the current drive to this amplifier due to the impedance change. Field effect transistor (FET) Q1B simultaneously couples the trigger level signal to the other input of differential amplifier Q3, Q4.

The out-of-phase signals from differential amplifier Q3, Q4 are buffered by emitter followers Q9 and Q10; then, are fed to the output shaper section.

## 3) OUTPUT SHAPER

The output shaper is a conventional Schmitt circuit consisting of transistors Q5 and Q6 followed by emitter follower Q7. Transistor Q7 isolates and translates to a MECL level for further buffering by U1. Inversion is accomplished in the gate package. Transistor Q8 is a voltage translator to provide a gate signal to U1. When a positive level appears at Pin 24, the signal is passed through U1. When at zero, the signal is inhibited at U1.

### 4.4.2 10 MHz Amplifier - A18, A19 (Schematic 39328)

The "B" and "C" INPUT circuits are identical printed circuit boards, each consisting of three distinct operating circuits:

The Attenuator section is front panel switch-controlled and may be remotely programmed to present the Amplifier section with a signal which is equal to; 1/10 of; or 1/100 of the input signal, while maintaining a constant 1 M $\Omega$  load on the input connector. The DC-AC remote selection network is also incorporated into the Attenuator section.

The Amplifier section converts the high-impedance, single-ended input to a low-impedance, differential output of sufficient amplitude to activate the differential input trigger circuit of the shaper.

The Shaper section inparts a uniform rise time and amplitude to the signals from the Amplifier section for use by the slope selection logic and marker outputs, which drive the function control logic.

### 1) ATTENUATOR

The signal from the input connector is coupled through the dc blocking capacitor C1. If dc operation is desired, DC-AC relay K1 may be energized, shorting capacitor C1. If an attenuation ratio of X1 has been selected, relay K2 is energized, connecting the signal directly through capacitor C19 to transistor Q1A. Relays K3 and K4 are open, thus presenting the Amplifier section with, essentially, the input signal. If the input signal exceeds  $\pm 5$  volts, Zener diodes VR1 and CR2 will conduct, protecting the Amplifier

section from damage.

If an attenuation ratio of X10 is selected, relay K3 is closed and relays K2 and K4 are open. Relay K3 connects the low end of resistor R4 to ground. Resistors R2 and R4 form a 10:1 voltage divider, presenting the Amplifier section with 1/10 of the input signal. The combined resistance of R2 and R4 provide a 1 M $\Omega$  load to the input signal.

If an attenuation ratio of X100 is selected, relay K4 is closed and relays K2 and K3 are open. Relay K4 connects the low end of resistor R5 to ground. Resistors R2, R3 and R5 form a 100:1 voltage divider, presenting the amplifier section with 1/100 of the input signal. The combined resistance of R2, R3 and R5 provides a 1 M $\Omega$  load to the input signal.

## 2) AMPLIFIER

Field effect transistor (FET) Q1A provides impedance matching between the input attenuator circuit and differential amplifier Q2, Q3. Field effect transistor (FET) Q1B simultaneously couples the trigger level signal to the other input of differential amplifier Q2, Q3. The outputs from this amplifier are coupled to the inputs of differential amplifier Q4, Q5. Outputs from transistors Q4, Q5 are fed to Trigger Shaper Q6, Q7/Q8, Q9.

## 3) TRIGGER SHAPER

The Trigger Shaper (transistors Q6, Q7/Q8, Q9) is a differential-type trigger circuit that converts the outputs of the previous amplifiers into a rectangular waveform. With transistors Q6, Q7 providing positive current feedback, transistors Q8, Q9 form a trigger circuit with approximately 0.5 V of hysteresis. The outputs are connected to differential amplifier Q10, Q11, the positive or negative outputs of which, are selected by the SLOPE switch. When the SLOPE switch is in the positive position, the + SLOPE line is grounded; thus, logic element U1-11 is "off" and logic element U1-6 is turned "on". This permits the positive output from transistor Q11 to pass through logic elements U1-6 and U1-8.

When the SLOPE switch is in the negative position, the ground is removed from the + SLOPE line; thus, logic element U1-3 is "on" permitting the negative output from transistor Q10 to pass through logic elements U1-3 and U1-8.

## 4) "B" OR "C" MARKERS (OUTPUT)

Marker outputs are provided by logic elements U2-3, U2-11 and U2-8. Pulse markers are generated by the logic elements U2-3 and U2-11 (one-shot). A level of 0 to +4.5 V is provided at the output of logic element U2-8. These pulses are amplified by transistor Q12 which provides +12 V pulses, 1 microsecond in width from a 1 k $\Omega$  source.



#### 4.4.3 200 MHz Decade and Gate - A12 (Schematic 39324)

This card contains four separate functional sections. These sections are: 1) Count Select Section, 2) Start/Stop Select Section, 3) Gate Section, and 4) High Speed Decade Section.

##### 1) COUNT SELECT SECTION

The Count Select Section is comprised of logic element U1 and its attendant discrete components shown in the referenced schematic diagram. This circuitry selects one of four possible signal sources to be counted. If the output of the "A" amplifier, for example, is to be counted, the control line on Pin X is grounded and the control lines on Pins 17, 20, and 21 are raised to a positive level between 3 and 5 volts. This programming allows the "A" amplifier output, present on Pin 19, to pass through logic elements U1-3 and U8-14 to the clock input of the High Speed Decade. Simultaneously, the time base, 100 MHz multiplier, and frequency extender signals are inhibited from access to logic element U8-14. Each of the four signals may be programmed in the same manner, (i.e.) ground the control line associated with the signal of interest and maintain a positive level on the other three control lines.

##### 2) START/STOP SELECT SECTION

The Start/Stop Select circuitry includes logic elements U5, U7, U9, U12, sections of U2, U6, and U11, transistors Q1, Q2, Q3 and associated discrete components shown in the referenced schematic diagram. This circuitry selects one of five possible signal sources to control the gate length. Transistors Q2 and Q3, along with logic elements U2-8 and U2-11, control which slope of the signal from the "B" amplifier will activate the gate when the Period X1 function is selected by grounding Pin L. Grounding Pin L enables logic elements U11-3 and U11-6, allowing each to pass to the Gate Section, signals received from logic element U9. The signal from the "B" amplifier is converted from  $T^2$  logic levels to ECL logic level by inverting transistor circuit Q1. The signal is inverted again in logic element U11-8 to reestablish the slope of the signal. This signal is fed to logic element U5-1 which provides two signals that exhibit a 180° phase relationship. These two signals are connected to logic element U9. The Slope Selection circuitry enables the various sections of logic element U9, such that it may pass the proper phase signal to logic elements U11-3 and U11-6.

If the gate length is to be determined by the time base signal, Pin 8 is raised to a positive level of between 3 and 5 volts. This enables logic element U6-8, allowing the time base signal present on Pin U to pass. The output of U6-8 is capacitively coupled to the input Gate Section. The inputs to logic elements U12-1 and U12-13 are dc-biased to approximately -2 volts, in order that a positive transient

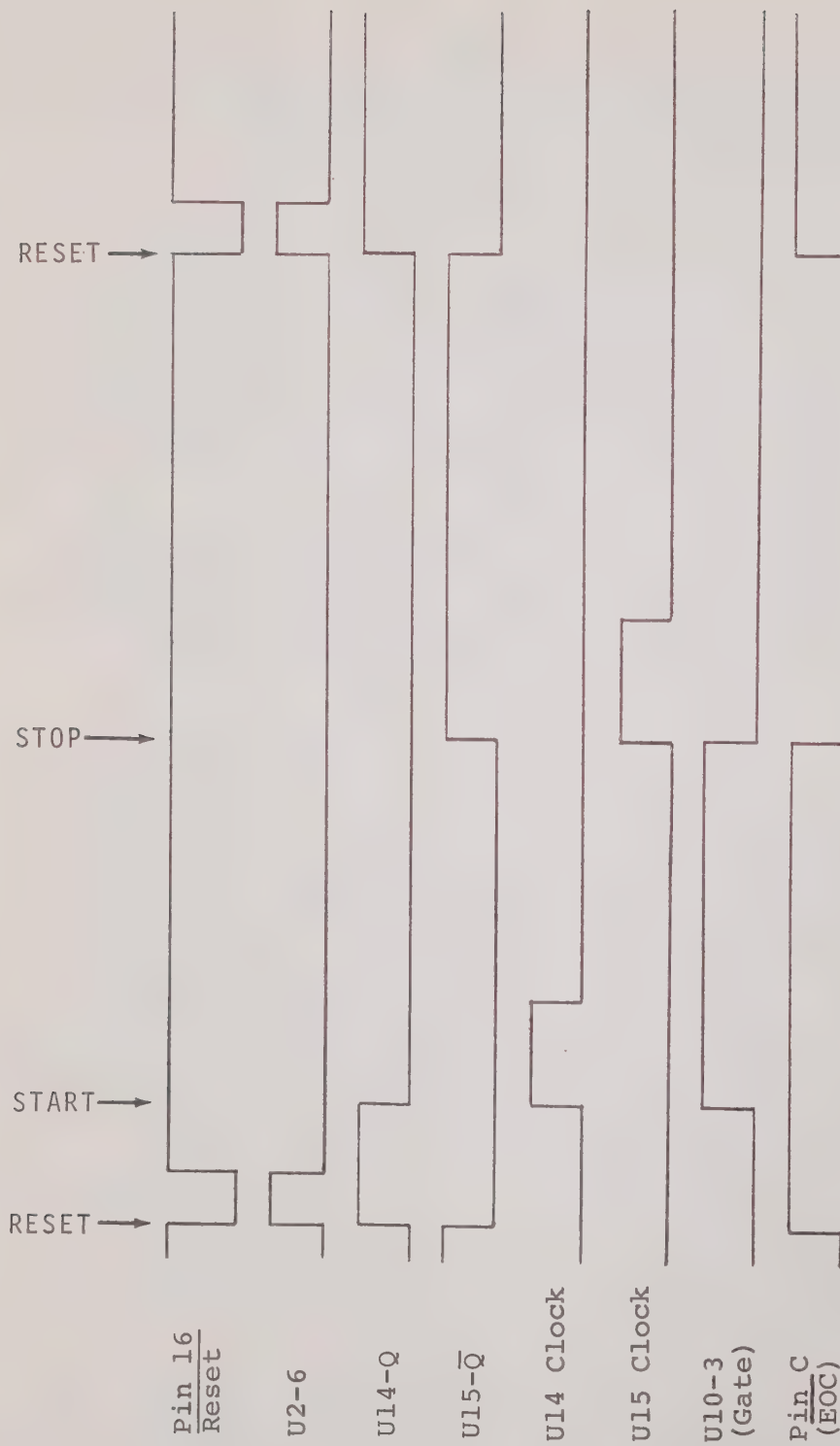


FIGURE 4.4 MAIN GATE TIMING DIAGRAM

of +2 or more volts coupled to each element from logic elements U6 or U7, will cause a positive transient on the outputs. These positive transients are transmitted to the Gate Section as Start/Stop signals.

### 3) GATE SECTION

The Gate Section includes logic elements U8-3, U10, U14 and U15 (see Figure 4.4, Main Gate Timing Diagram). Flip-flops U14 and U15 receive the Start/Stop signals from the Start/Stop Select Section and generate a level, the duration of which, is equal to the elapsed time between the Start and Stop signals. When this level (at U10-3) is applied to logic elements U8-3 and U10-14, the High Speed Decade Section is allowed to run at the rate of the clock signal supplied from the Count Select Section. When the gate level is removed (end of gate time), the High Speed Decade is inhibited from running. The gate level, when present, is converted to  $T^2$  logic level in one section of logic element U16 and presented to Pin H. Flip-flop U15 is clocked by the Stop signal from the Start/Stop Select Section and is reset at the instrument reset time, thus generating a level which exists between gate-off and reset. This level is termed E.O.C. (End-of-Count) and is converted to  $T^2$  logic level in another section of logic element U16 for transmission to other circuits via Pin C.

Should a totalizing function be required of the Gate Section, Pin E is raised to a positive level between 3 and 5 volts. This will cause flip-flops U14 and U15 to be held in a reset state and shift control of logic elements U8-3 and U10-14 to Pin D via logic element U3-3. Thus, when Pin D is grounded, the High Speed Decade Section is allowed to run at the rate of the clock signal supplied by the level between 3 and 5 volts, the High Speed Decade Section is inhibited. Since flip-flop U15 is maintained in its reset state by the level on Pin E, no E.O.C. is generated.

### 4) HIGH SPEED DECADE SECTION

The High Speed Decade Section includes: flip-flops U13, U18, U19 and U20; logic elements U4 and U17; and Q4, Q5, with their attendant discrete components. (See Figure 4.5, 200 MHz Decade Timing Diagram.)

The decade proper is formed by flip-flops U13, U18, U19 and U20 connected in a conventional  $\div 2$ ,  $\div 5$  configuration. Flip-flop U13 is a high speed "D" type circuit connected so that it will toggle freely. This forms the  $\div 2$  portion of the decade. The  $\div 5$  portion is formed by "JK" type flip-flops U18, U19 and U20. These are connected so that the "2" bit (U18) is permuted by the action of the "8" bit (U20). The output coding of the decade is a conventional positive true 1-2-4-8 derived from the Q outputs of the four flip-flops. The Q outputs of the 1, 2, and 4 bits are connected directly to level converter U17. The  $\bar{Q}$  output of the 8 bit is inverted in logic element U4-8 and connected to the fourth

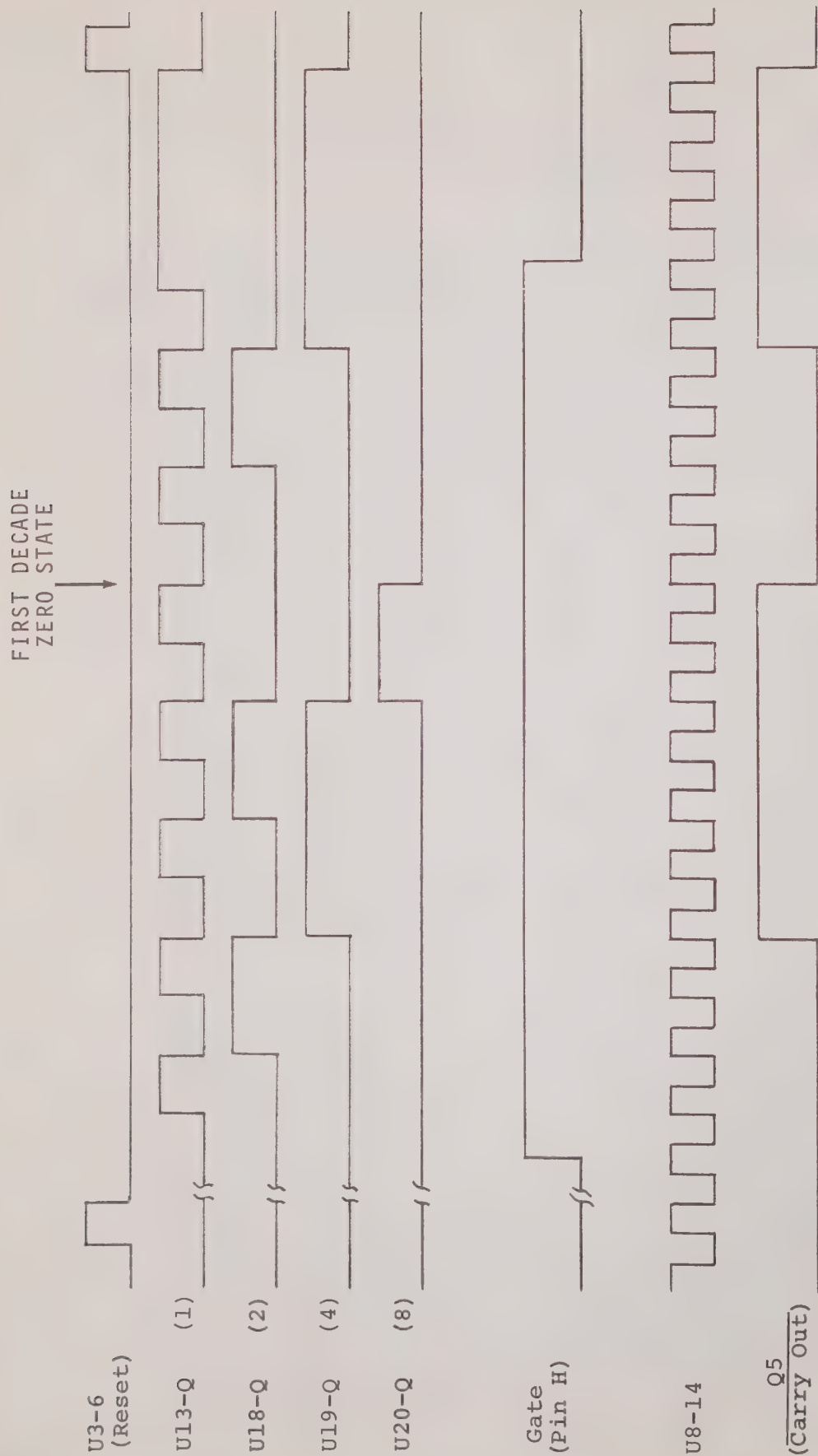


FIGURE 4.5 200 MHz DECADE TIMING DIAGRAM

section of level converter U17. The outputs from level converter U17 are at DTL logic levels and reflect the static state condition of the decade proper. The Carry output of the decade (Pin CC) is derived from an "OR" condition of the 4 and 8 bits. This is accomplished in logic element U4-11. This combined signal is used to drive high-speed level converter Q4 which is buffered by Q5. The Carry output signal has a 6 to 4 level ratio and is at  $T^2$  logic levels. Reset is applied to the decade from Pin 16 via logic element U3-3.

#### 4.4.4 Legend Logic - A8 (Schematic 39332)

This circuitry provides a BCD output to the Readout (A1) card which decodes and displays the proper units of measure as selected by the FUNCTION and RESOLUTION switches. Coding is accomplished through a series of NAND-NOR logic gates. Logic summation, complement generation, as well as asterisk generation is accomplished on this assembly. Table 4.2 describes the BCD outputs of the card for the units of interest.

#### 4.4.5 Decimal Logic - A9 (Schematic 39336)

This assembly provides a BCD output to the Readout (A1) card which decodes and displays the decimal in the proper location as selected by the FUNCTION and RESOLUTION switches. Coding is accomplished through a series of NAND-NOR logic gates. Logic summation, complement generation, and decimal location, in the form of a BCD code, is accomplished on this assembly. Table 4.3 indicates the BCD outputs of the card for a specified decimal location.

#### 4.4.6 Function Control - A11 (Schematic 39340)

The assembly is comprised of two major circuit groups: function logic summation and selection; automatic/manual recycle and data-transfer pulse generation.

##### 4.4.6.1

Circuitry of the first group combines, for signal/gate selection and control purposes, the selected positions of the FUNCTION and RESOLUTION switches.

The gates for this logic are found primarily on assemblies A1, A10, and A12. As an example, the following gate controls are developed:

- 1) When in the P/R X1 mode (not Test) and (not Ratio), PER X1 + TEST Pin 10 will be negative.
- 2) When in the COUNT A, RATE A or RATIO modes (but not in Test or 10 ns), the COUNT A AMP, Pin 19, will be negative.
- 3) If RATE D, 10 ns, TEST, and COUNT A modes have not been selected, COUNT T.B., Pin 17, will be negative.



TABLE 4.2 LEGEND LOGIC OUTPUT CODE

| MEASUREMENT UNITS           | BCD WEIGHT/OUTPUT PINS             |         |         |          |
|-----------------------------|------------------------------------|---------|---------|----------|
|                             | 1<br>P11                           | 2<br>P2 | 4<br>P7 | -<br>P21 |
| * (Invalid Switch Position) | 0                                  | 0       | 0       | 1        |
| MHz                         | 1                                  | 0       | 0       | -        |
| kHz                         | 0                                  | 1       | 0       | -        |
| sec                         | 1                                  | 1       | 0       | -        |
| ms                          | 0                                  | 0       | 1       | -        |
| μs                          | 1                                  | 0       | 1       | -        |
| Gate                        | Driven from Function Control Board |         |         |          |

TABLE 4.3 DECIMAL LOCATION OUTPUT CODE

| DECIMAL LOCATION | BCD WEIGHT/OUTPUT PINS |          |           |
|------------------|------------------------|----------|-----------|
|                  | 1<br>P17               | 2<br>P18 | 4<br>P"B" |
| $10^0$           | 0                      | 0        | 0         |
| $10^1$           | 1                      | 0        | 0         |
| $10^2$           | 0                      | 1        | 0         |
| $10^3$           | 1                      | 1        | 0         |
| $10^4$           | 0                      | 0        | 1         |
| $10^5$           | 1                      | 0        | 1         |
| $10^6$           | 0                      | 1        | 1         |
| $10^7$           | 1                      | 1        | 1         |

- 4) If RATE A or RATE D, and TEST modes are selected, COUNT 100 MHz Pin 18, will be negative. When the 10 ns, RATE A or RATE D, RATIO or TEST modes are selected, COUNT 100 MHz Pin 18, will be negative.
- 5) If the COUNT A or HOLD function is selected, the cross-coupled NAND gates U6-8 and U6-6 will flip and produce a positive level at Pin U6-8. This state will exist until some function other than COUNT A or HOLD is selected.

#### 4.4.6.2

The control pulse generation requirements are as follows:

- 1) Resetting of the instrument to generate a time zero reference.
- 2) Transferring of the accumulated data to storage and display at the correct time.

Reset occurs when an E.O.C. (End-of-Count) negative condition exists at Pin 3 (assuming the INHIBIT RESET, Pin S, to be positive). In this condition the base of transistor Q1 will be negative (ground). This permits the charging of capacitors C4, and C6 dependent in part on the condition of the Fast-Slow switch, at a rate determined by the Recycle Rate potentiometer and resistor R12. When the intrinsic standoff voltage of transistor Q2 is reached, a negative pulse is created at the junction of resistor R14 and capacitor C7. This pulse triggers the one-shot comprised of logic elements U13 and U12. The signal is inverted and buffered for distribution by logic elements U11, and transistors Q3 and Q4. A negative (ground) signal at Pin S will prevent this automatic recycle from occurring.

The reset pushbutton signal is conditioned and shaped by inverter U13, along with one-shot U14-6 and U12-3. The output on Pin V is returned to Pin X as the DEMAND RESET. The one-shot is used to prevent a multiplicity of pulses from occurring due to the mechanical nature of pulse activator S3.

Transfer action occurs if the Storage switch is in the "on" condition and the instrument is not in Count or Hold; the output of logic element U12-11 will be negative. Inverter U13-3 will present to gate U11-6 a positive input. DEMAND RESET line Pin X will be high as is the quiescent state of the one-shot output U14-3. Therefore when a differentiation of the negative-going E.O.C. signal occurs, it triggers one-shot U14-11 and U14-3, with a resulting transfer pulse at the output of U11-6. The positive bias to transistor Q5 is removed by inverter-driver U14-8 and a positive transfer pulse appears at TRANSFER output Pin R.

With the storage switch in the "off" position, Pin 15 is negative (ground) causing the output of logic element U12-11 to be positive; the output of inverter U13-3 to be negative; the output of gate U11-6 to be positive; and, the output of inverter-driver U14-8 to be negative. This condition holds the output of transistor Q5 in a positive state, ensuring continuous transfer of data as it changes.

#### 4.4.7 Time Base - A10 (Schematic 39344)

This assembly provides two major functions:

- 1) a. Provides a time selectable in factors of ten which is referenced to the internal frequency standard.
- b. Provides a scaled frequency in factors of ten which is referenced to the internal frequency standard.
- c. Provides frequency division in factors of ten which is referenced to the input frequency at the "A" INPUT.
- 2) a. Allows for Period and Ratio averaging by accumulating in factors of ten, the number of events to be averaged.
- b. Provides a continuous 1 kHz frequency for use with the Automatic Computing Transfer Oscillator (ACTO\*).

The divide chain, comprised of integrated circuits U1 through U8, accepts inputs as controlled by gate U18. These inputs are scaled by a factor of ten and are available for selection by gates U16, U15 and U19-6. The selected output is inverted by gate U14-6 and is available for timing purposes, or as a known frequency for TIM or Period measurements. The same gates are used for scaling an input frequency with the buffered output appearing at U14-3 for the Time Base SCALE OUTput at the rear panel. Gate U17-8 is activated during Rate D operation to remove decade divider U1 from the count chain.

When the EXTERNAL/INTERNAL TIME BASE switch is in the EXTERNAL position, gate U15-8 is activated and the external selected frequency is available as a time-frequency standard.

The divide chain, comprised of integrated circuits U9 through U13, accepts inputs from gates U19-3, U19-8 and U19-11. Gate U19-3 is activated for all Rate functions and supplies a continuous 1 kHz signal for the ACTO "N" computer circuit. When in the Period or Ratio mode the "B" amplifier is presented to this decade chain through gate U19-8. The output signals from the decade chain are available for selection by gates U21 and U22. Logic element U21-3 inverts and buffers the selected output for use in the instrument.

#### 4.4.8 Attenuator Select - A6 (Schematic 39352)

This board assembly provides a means of interconnecting the front panel controls to the internal assemblies. When used in conjunction with the remote programming option for this instrument, different board assemblies are inserted in these positions to perform the Local-Remote function.

\*ACTO - Registered T.M.

#### 4.4.9 Function Select - A7 (Schematic 39800)

This assembly provides a means of interconnecting the front panel controls to the internal assemblies. Logic elements U1 and U2 generates the required logic summation to provide a ground closure for the Resolution switch.

#### 4.4.10 10 MHz Oscillator A3 (Schematic 39356)

The assembly is composed mainly of two circuits:

- 1) A 10 MHz crystal-controlled oscillator.
- 2) Circuitry for comparing the phase of the oscillator with an unknown, but harmonically related signal for the purpose of deriving a dc control voltage that is proportional to the phase difference between the two signals.

The oscillator is basically of the Colpitts type with a 10 MHz crystal as an integral part of the feedback and frequency determining network. The oscillator is followed by appropriate buffers for distribution throughout the instrument. Frequency of the oscillator is controlled by capacitors C2, C3, and diode CR3.

The 10 MHz signal is divided by two and presented to sample diodes CR8 and CR9. The sample network is driven by integrated circuit U5-9 and logic element U3-3. The EXT/INT STD FREQUENCY INPUT signal is divided by two in integrated circuit U5-2; then, inverted in logic elements U3-6 and U3-11. An error voltage is developed at the junction of resistors R18 and R19 if the two signals are out of phase. This error voltage is amplified by amplifier U4 and applied to diode CR3 to correct the 10 MHz oscillator, keeping it harmonically related and phase-locked to the unknown input. Figure 4.6 describes the lock range of frequencies which are harmonically related.

#### 4.4.11 100 MHz Multiplier - A4 (Schematic 39360)

The 100 MHz multiplier consists of: 1) a 10 MHz amplifier; 2) a times-five frequency multiplier; and 3) a times-two frequency multiplier. The frequency multipliers are cascaded to give a composite multiplication factor of ten.

Transistor Q3 circuitry inparts power amplification and some desired harmonic filtering to the 10 MHz signal received from the oscillator. The output of this circuit is coupled through capacitor C2 to the base of transistors Q1 and Q2. These transistors are connected in a complementary amplifier circuit to provide further power gain to drive the times-five multiplier.

The times-five multiplication is accomplished by tuning parallel tank inductor L2/capacitor C10 and inductor L3/capacitor C12 to 50 MHz. Coupling between these two circuits is provided by capacitor C11. The 50 MHz output from the circuit is applied to the base of transistor Q4. The Q4 collector tank, consisting of inductor L4 and capacitor C15, is tuned to 100 MHz. This 100 MHz signal is coupled through capacitor C18 to the tapped output matching tank inductor L5/capacitors C16, C17.



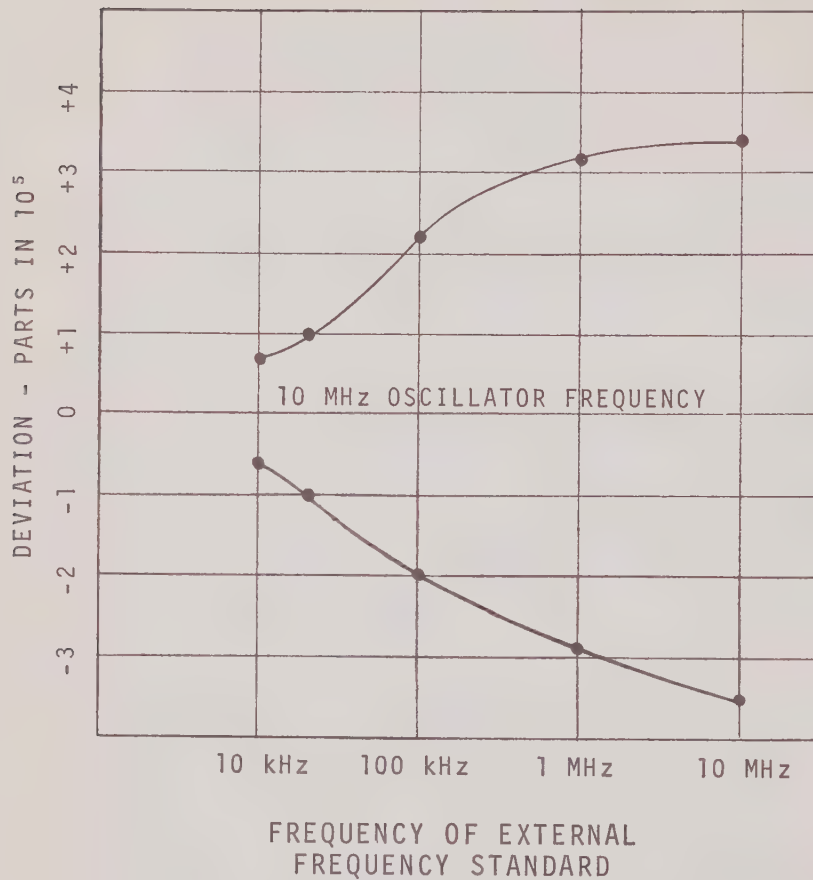


FIGURE 4.6 RELATIONSHIP OF 10 MHz OSCILLATOR DEVIATION vs EXTERNAL FREQUENCY STANDARD INPUT.



#### 4.4.12 3 MHz Oscillator Power and Frequency Divider - A2 (Schematic 39364)

The assembly serves two functions:

- 1) Provides source of regulated power for the high-stability 3 MHz oscillator.
- 2) Provides for frequency division from 3 MHz to 1 MHz.

A reference voltage is developed by reference amplifier U1 as a function of the voltage at the junction of resistor R3 and R4, and the unregulated input voltage at Pin N. The output voltage is compared against the internal voltage reference, with the signal drive to series regulator Q1 being continuously monitored to maintain the output voltage at Pin L constant in amplitude.

The 3:1 frequency division takes place following buffer amplifier Q2. The high-stability oscillator produces a 3 MHz signal which is then divided down to 1 MHz to provide the suitable lock signal for the 10 MHz oscillator. Two binaries contained in integrated circuit U2 are interconnected to produce the division by three. The binaries are gated to an "off" condition by grounding Pin P when in the EXT STD FREQ INPUT switch position.

#### 4.4.13 3 MHz Oscillator - U1

This unit consists of a sealed crystal oscillator and temperature-controlled oven. Any effort to open or repair this assembly in the field will void the applicable warranty on the unit. Defective units must be returned to the factory for service.

Power for this assembly is obtained from a separate power supply assembly (Assembly A2) which operates independent of the instrument power switch. Whenever the instrument is plugged into the appropriate power outlet, this separate power supply maintains the oven temperature constant, even when the instrument power switch is in the "off" position.

#### 4.4.14 Automatic Computing Transfer Oscillator - "D" Input (Figure 4.7)

The Automatic Computing Transfer Oscillator (ACTO) operates by phase-locking a low-frequency oscillator to the applied RF input frequency and solving for the harmonic multiple "N". The counter time base is then expanded so that the instrument will count the low-frequency oscillator for a period equal to "N" times the selected time base. The result is a direct indication of the RF input frequency.

When the ACTO is in the phase-lock condition, the voltage-controlled oscillator (VCO) is an exact submultiple of the unknown RF input.

The low-frequency drive to the "B" channel mixer varies from the VCO frequency by precisely 1 kHz. Mathematically, the various frequencies are as follows:

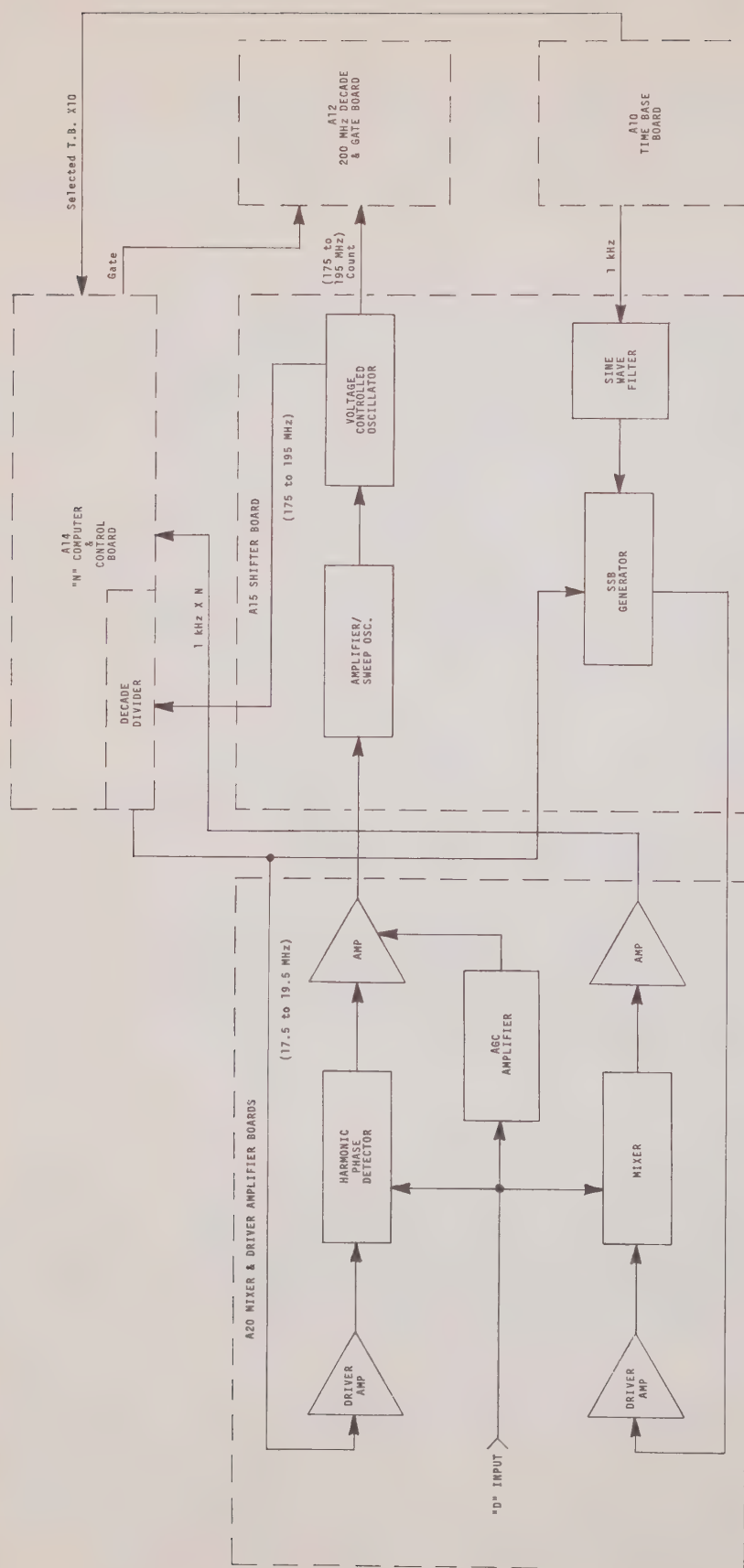


FIGURE 4.7 BLOCK DIAGRAM, AUTOMATIC COMPUTING TRANSFER OSCILLATOR (ACTO).

F = frequency of voltage-controlled oscillator.

$N \times F$  = RF input

$N (F + 1 \text{ kHz}) = \text{RF input} + (1 \text{ kHz} \times N)$

The output of the "N" channel mixer becomes  $1 \text{ kHz} \times N$ . In order to directly indicate the RF input signal, "N" must be computed and the counter measurement period lengthened by the factor "N".

As illustrated in Figure 4.7, the ACTO incorporates a drive/amp-  
lifier, phase detector, amplifier/sweep oscillator, a voltage-  
controlled oscillator and decade divider to form a "phase-lock  
loop". The free-running sweep oscillator tunes the voltage-con-  
trolled oscillator over a band of frequencies, producing an output  
which varies in frequency between 175 and 195 MHz. This signal is  
divided by ten; then, applied to the harmonic phase detector through  
the driver/amplifier and is phase-compared to the RF input. When  
an exact oscillator harmonic is encountered, a dc voltage is gen-  
erated which disables the sweep oscillator and locks the voltage-  
controlled oscillator to a submultiple of the input frequency.  
However, since the harmonic number (N) is unknown, it is not yet  
possible to measure the exact input frequency.

A second output from the decade divider is extracted and applied  
to a single-sideband generator. The generator is modulated at a  
 $1 \text{ kHz}$  rate, resulting in an output equal to the oscillator frequency  
shifted by  $1 \text{ kHz}$ . This signal is then applied to the mixer circuit,  
the output of which, is equal to  $1 \text{ kHz} \times N$ .

Since the original  $1 \text{ kHz}$  modulation frequency and the  $1 \text{ kHz} \times N$   
are present, it is possible to compare the two frequencies digitally  
and extract the corresponding harmonic number (N). This is the  
function of the N compute and control circuit. After extracting N,  
the N compute and control circuit expands the time base period by  
the appropriate factor of N to provide a direct readout of the in-  
put frequency.

#### 4.4.14.1 Mixer and Driver/Amplifier - A20 (Schematic 27988)

The voltage-controlled oscillator signal is shaped by transistor  
Q101 and Q102 to produce positive pulses across inductor L103.  
This output passes through emitter Q105 then drives the anode of  
step-recovery diode CR101. Due to the snap-off action of this  
diode, the comparatively slow-rising negative pulses developed by  
transistor Q101 become high-speed transients. Positive transients  
are present on the cathode and negative transients are present on  
the anode step-recovery diode CR101. These transients are differen-  
tiated by CR101 and R1/C102 and R2 to form very fast pulses, typically  
 $0.5 \text{ nanosecond}$  wide and  $1.0 \text{ volt}$  in amplitude.

The positive pulse is coupled to diode CR2 through capacitor C1, and  
the negative pulse is coupled to diode CR1 through capacitor C2.  
The RF to be measured is directly coupled to the junction of CR1  
and CR2. A voltage is present at the junction of resistor R5 and  
R6 which is proportional to the phase difference between the RF  
input and a particular VCO harmonic contained in the pulses which  
drive diodes CR1 and CR2.



Since the signal present at the junction of resistors R5 and R6 is small (approximately 200 mV p-p), it must be amplified. To accommodate large variations in signal level, the gain of amplifier U1 is effectively controlled by the AGC amplifier through gain control FET Q3.

The circuitry described above has been for the "phase-lock loop" channel driver/amplifier. The "N" channel driver/amplifier (Q103, Q104, and associated components) is identical in operation. The output of the "N" channel mixer (junction of resistor R7 and R8) is applied to the gate of FET source follower Q2 which, in turn, drives amplifier/shaper U3. The output from amplifier/shaper U3 (1 kHz X N) is connected out through Pin X.

Automatic control of amplifier gain (AGC) is accomplished as follows: The RF input level is detected by diode CR5. The resultant dc is amplified by amplifier U2, which biases gain control FET Q3. By varying the bias on the gate of Q3, the dynamic impedance from source to drain can be controlled; therefore, the gain of the amplifier will be automatically adjusted by the amplitude of the RF signal being measured.

As a harmonic of the voltage-controlled oscillator (divide-by-ten) approaches the input frequency, the difference frequency decreases. When the difference frequency falls below 1 MHz, the low-bandpass amplifier passes and amplifies the signal. The output is directly coupled to Pin C. The voltage, developed across resistor R5 nullifies the drive to the sweep oscillator, resulting in a dc output. This dc voltage holds (or locks) the VCO at a frequency, the harmonic of which, equals the RF input; thus, accomplishing phase lock.

#### 4.4.14.2 Sweep Oscillator - A15 Shifter (Schematic 39368)

The sweep oscillator generates the triangular waveform that sweeps the voltage-controlled oscillator (VCO). Transistors Q1 and Q2 form a binary switch. In the following example and with no input present, transistor Q1 conducts while Q2 is held "off". Current flow through resistor R4 and transistor Q1 causes amplifier U1 to invert and, due to the feedback network (capacitor C1 and resistor R3), produce a linear rise in voltage at the output. When the output voltage reaches +10 volts, VR1 conducts, forward biasing transistor Q2. Transistor Q2 conducts while transistor Q1 is held "off". This action causes amplifier U1 to draw current from the positive supply through resistor R1, driving the output in a negative direction. The output continues to drive in a negative direction until it reaches -5 volts. At -5 volts, transistor Q2 is turned "off" and transistor Q1 is turned "on"; thus, repeating the cycle. The net effect of this circuit is a triangular waveform varying between +10 volts and -5 volts as seen at TP1.

#### 4.4.14.3 Voltage-Controlled Oscillator - A15 Shifter (Schematic 39368)

The triangular waveform is now applied to the base of emitter follower Q3, and into the voltage-controlled oscillator (VCO) frequency

determining tank circuit (CR4, CR5 and L2). CR4 and CR5 are "varicap" type diodes with a capacitance characteristic inversely proportional to the bias applied. Figure 4.8 depicts a typical "varicap" curve.

As illustrated, the varicap curve is nonlinear. To compensate for this nonlinearity, corrective networks consisting of a resistor and a diode in series (R9, CR1 and R11, CR2) are placed across the triangular wave generator load resistor R10. The effect of these two networks is a nonlinear curve which opposes the varicap curve, resulting in a more linear function (see Figure 4.9).

#### 4.4.14.4 Single-Sideband Generator - A15 Shifter (Schematic 39368)

The divide-by-ten output from the voltage-controlled oscillator (Pin Z out to "N" computer divider and returned through Pin X), must be shifted in frequency by 1 kHz in order to properly drive the "N" channel harmonic mixer and must be sinusoidal to drive the single-sideband generator.

This signal is filtered by resistor R24, capacitor C16, and inductor L6 to reduce harmonic distortion, and is then split into two components, separated in phase by 90°. Phase separation is accomplished by an LR phase-lag circuit (L10, R50) and CR phase-lead circuit (C30, R49). The resultant signals are used to drive the balanced modulators in integrated circuit U2.

Simultaneously, a 1 kHz signal from the time base (Pin F) is routed to the base transistor Q7. Transistor Q7 inverts and amplifies the signal. A "twin-T" notch-filter on the collector of transistor Q7 is tuned to 1 kHz, passing all other frequencies. FET Q6 provides a negative feedback path for all frequencies except 1 kHz. The remaining 1 kHz signal, at the collector of transistor Q7, is now capacitively coupled to the base of inverting amplifier Q8. Two separate 1 kHz signals, 90° out of phase, are extracted from Q8. The noninverted signal is from the emitter circuit and the 90° leading signal is from the collector circuit. These signals are capacitively coupled to the balanced modulators. The first modulator removes the carrier frequency and the second modulator removes one sideband, resulting in a single sideband. The net effect of this action is the shifting of the carrier frequency by 1 kHz. The balanced modulators (U2) are a pair of differential amplifiers utilizing the carrier to drive the common mode input. Integrated circuit U3 sums the outputs of the balanced modulators and converts them to a single output available at Pin 3 (connector J3).

#### 4.4.14.5 "N" Computer - A14 (Schematic 39372)

The "N" Computer serves three basic functions:

- 1) Compute which harmonic of the voltage-controlled oscillator is mixing with the RF input to cause phase lock.
- 2) Expand the selected time base by the computed "N" number (harmonic number).
- 3) Provide a scale-of-ten divider on the output of the voltage-controlled oscillator.



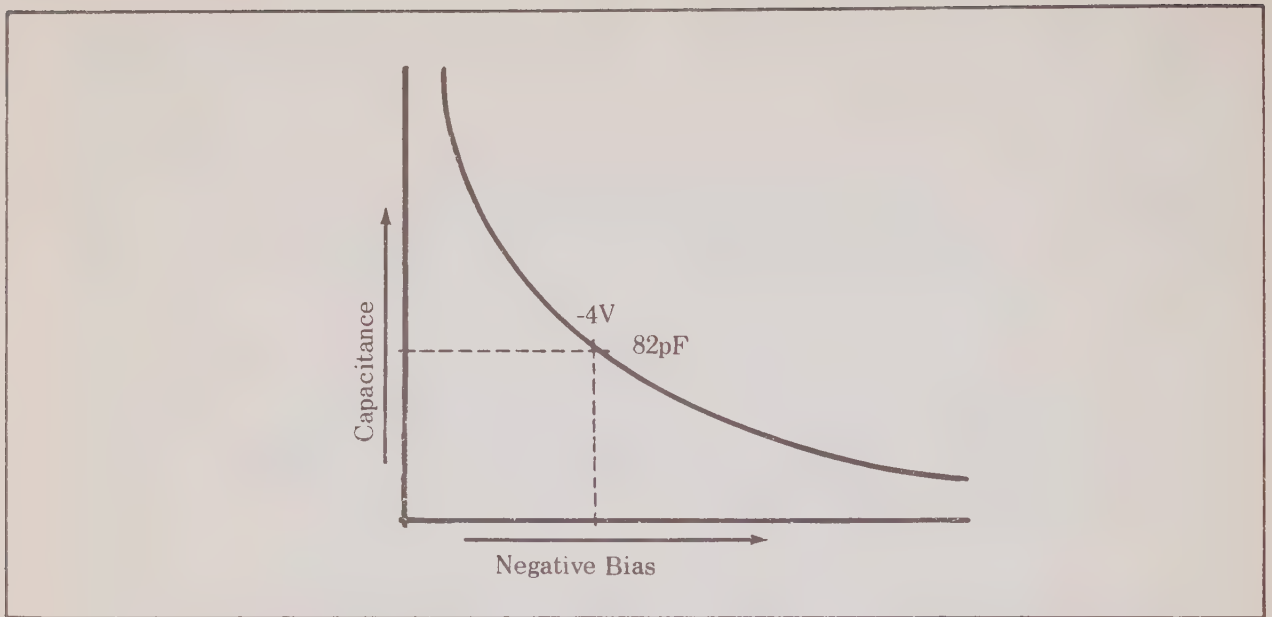


FIGURE 4.8 TYPICAL VARICAP CURVE

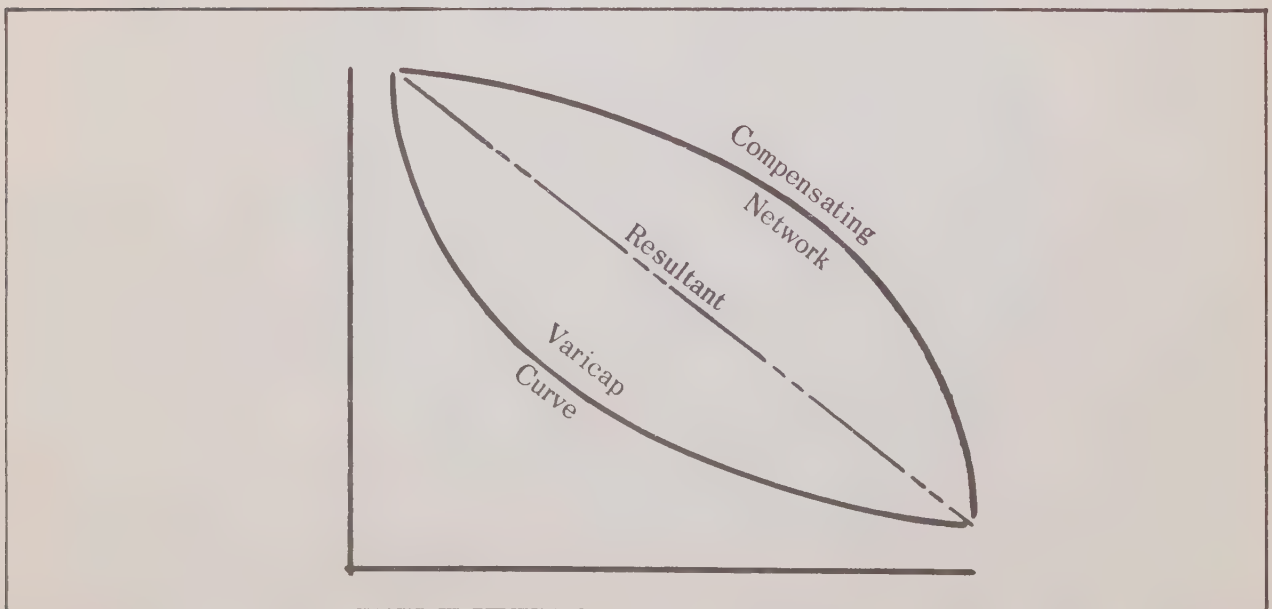


FIGURE 4.9 IDEAL VARICAP CURVE

### 1) COMPUTE N CIRCUITRY

The Compute N Circuitry consists of decade U4, dual "JK" type flip-flop U1, reversing accumulators U2 and U3, and logic elements U12-8, U12-11, and U14-11.

When the mixer has "locked" the voltage-controlled oscillator to the RF input, a signal, the frequency of which is equal to  $1 \text{ kHz} \times N$ , is applied to Pin 17 of the N Computer.

After the N Computer has been reset via Pin P, decade U4 starts counting at a 1 kHz rate from a constant 1 kHz signal supplied from the main counter time base via Pin E and logic element U12-8. When decade U4 has accumulated four of the 1 kHz pulses, Pin 8 rises to a positive level enabling dual "JK" type flip-flop U1.

Flip-flop U1 is connected as a  $\div 4$  circuit and is clocked by the  $1 \text{ kHz} \times N$  signal applied at Pin 17. The resultant output from Pin 9 of flip-flop U1 is applied through logic element U11-6 to the down-count input of reversing accumulator U2. Flip-flop U1 is held enabled for precisely four milliseconds as determined by the 1 kHz input and decade U4.

At the end of the four millisecond period, flip-flop U1 is disabled, and the number of counts stored in reversing accumulators U2 and U3 is equal to the harmonic number of the voltage-controlled oscillator mixing with the RF input (N number).

### 2) TIME BASE EXPANSION CIRCUITRY

The Time Base Expansion Circuitry includes dual "D" type flip-flop U5 and logic elements U13 and U14.

After the Compute N circuitry has been disabled by the action of decade U4, the Time Base Expansion Circuitry is enabled (also by decade U4) via logic element U12-11. The first time base pulse appearing at Pin L following the enable signal from logic element U12-11, sets Pin 8 of flip-flop U5 to its positive state, enabling logic element U14-8. The next succeeding time base pulse to arrive at Pin L is coupled through logic element U14-8 to Pin N and is used as a start gate signal by the main counter. The trailing edge of this same time base pulse is transmitted to the up-count input of reversing accumulator U2.

When a number of time base pulses equal to the N number previously stored in reversing accumulators U2 and U3 have been received, reversing accumulator U3 will generate a "carry out" pulse which sets the "RS" type flip-flop formed by interconnected logic elements U13-8 and U13-11. This enables logic element U14-3, allowing the next time base pulse arriving at Pin L to be conducted to Pin M for use by the main counter as a stop gate signal. The stop gate is equal to the applied time base period times the N number.

### 3) SCALE-OF-TEN DIVIDER CIRCUITRY

The Scale-of-Ten Divider Circuitry consists of a  $\div 2$ ,  $\div 5$

decade formed by flip-flops U6, U7, U8 and U9, and logic element U1D.

The flip-flops are connected in a conventional  $\div 2$ ,  $\div 5$  configuration. Flip-flop U6 is a high-speed "D" type and is connected such that it will toggle freely, forming the  $\div 2$  portion of the decade. The  $\div 5$  portion of the decade is formed by "JK" type flip-flops U7, U8 and U9, connected so that the "2" bit is permuted by the "8" bit.

The "4" bit output is buffered by logic element U10-15 and presented to Pin 20 for use by the Shifter assembly. The decade is clocked by the signal from the voltage-controlled oscillator present at Pin 22 via logic element U10-2. The output of logic element U10-2 is also presented to Pin BB via logic element U10-14 for use by the main counter. This is the signal counted during the expanded gate time.

#### 4.4.15 Readout - A1 (Schematic 39380)

This assembly consists of the following major circuit groups:

- 1) Display readout.
- 2) Display decoders and drivers.
- 3) Data storage.
- 4) Scaling decoders.
- 5) Units Driver.
- 6) Decimal Driver.
- 7) Off Scale (OS) indication driver.
- 8) Gate lamp driver.
- 9) Unallowable condition (\*) indication driver.

The display readout includes eight in-line, horizontal tubes of the neon-filled cold-cathode discharge type. As the cathodes are grounded, the elements ionize the gas, thus producing the numerical display. Current through the tubes is limited by the anode resistors.

The display decoder and drivers (integrated circuits U11 through U19) accept a binary-coded decimal input and convert the information to a one-of-ten output suitable for grounding the display tube cathodes.

The data storage devices (integrated circuits U11 through U19) accept and store, on command, binary-coded decimal information. When the transfer line, Pin 10 of connector J1 is positive, the input states (Pins 2, 3, 4 and 5) are transferred to the four storage binaries in U11. If the transfer line is held positive (Storage switch S23, "off"), each change of state at the input is reflected at the output.

If the transfer line is held at the negative state (ground), the information contained in the binaries when the transfer line was high, will be retained. The storage devices supply BCD output assembly A21.

The scaling decoder decades (integrated circuits U20 through U27) are a chain of decade dividers. The chain is reset to zero by a positive-going level on Pin 14 of connector J2. The 10° decade is located on the A12 assembly.

The measurement units driver U28 accepts binary-coded decimal information from the Legend Logic Assembly A8 and converts it to one-of-six outputs suitable for lighting elements of the annunciator unit.

The decimal driver U10 accepts binary-coded decimal information from the Decimal Logic assembly A9 and converts it to one-of-ten outputs suitable for lighting the decimals contained within the display tubes.

Off-Scale (OS) indication is obtained by sensing the carry output of the last decade in the chain. When this output occurs it is inverted by U29-6 and applied to the clock input of a "D-edge" triggered binary (U30A). The Q output goes positive. NAND gate U29-11 is now conditioned so that at data transfer an input is applied to the set pin of U30B. This produces a positive output at the Q1 pin which turns "on" off-scale lamp driver Q3, providing a ground for the OS indication.

The reset pulse is inverted by U29-3 and applied to the reset pin of U30A. This produces a negative (ground) at the Q output pin. This change of state is not transferred to U30B until the next transfer pulse. If the register has not been exceeded, no change-of-state takes place in U30A. Therefore, the next transfer pulse returns the Q1 output of U30B to the negative (ground) condition and the OS lamp is extinguished.

The Gate lamp signal information is derived from the Function Control assembly A11 and represents the actual time the main count gate is open (or is an expansion of the gate length, in the case of short gate duration), to provide a visual indication that the gate is operating.

The asterisk (\*) indicates an unallowable switch combination. The signal information is developed in the Legend Logic assembly A8. The indicator will light due to certain unallowable switch combinations (see Table 4.4).

#### 4.4.16 BCD Output - A1A2 (Schematic 39376)

The assembly provides a means of interconnecting various BCD options from the stored information of the Readout (A1) to the BCD output connector J12. The board provides a 5 kΩ pullup resistor for each BCD line. Positive true logic is employed, however, to inhibit the automatic reset, a closure to ground is required. The EOC (end-of-count) or "Print Command" is either a positive-going or a negative-going signal output. All lines are TTL compatible. It should be



noted that the print command signals are from a +12 volt source through a 1 k $\Omega$  resistor to be compatible with certain printers.

#### 4.4.17 Main Power - A13 (Schematic 39348)

The power supply circuits supply four regulated voltage outputs of +5 V, -5.2 V, +12 V and -12 V dc. It also supplies unregulated voltages of approximately +225 V dc and +9 V dc.

The voltage regulator circuits make use of integrated circuit regulators and series pass transistors. The +12 V and -12 V dc supplies have independent voltage regulators; the +5 V supply requires +12 V for the reference supply and the -5.2 V supply requires +5 V for its reference supply. This is necessary because the integrated circuit regulators have a 7 V reference element.

TABLE 4.4 UNALLOWABLE SWITCH SETTINGS

| RESOLUTION (Pushbutton) | FUNCTION (Switch)                                                                                |
|-------------------------|--------------------------------------------------------------------------------------------------|
| Ratio                   | TIM<br>RATE A<br>RATE D                                                                          |
| 10 ns                   | RATE A<br>RATE D                                                                                 |
| .1 $\mu$ s              | RATE A<br>RATE D                                                                                 |
| 10 seconds              | TIM<br>X1<br>X10<br>X10 <sup>2</sup><br>X10 <sup>3</sup><br>X10 <sup>4</sup><br>X10 <sup>5</sup> |



## CHAPTER 5 MAINTENANCE

### 5.1 INTRODUCTION

This chapter contains procedures for adjustment and calibration of the Model 6153-50. It also contains troubleshooting and repair information to aid the user in maintaining the instrument in proper operating condition. Whenever a Systron-Donner instrument requires service, the nearest S-D representative should be contacted. He can provide field service, or arrange factory returns, when necessary. Address all inquiries on operation or application to your nearest sales representative; or, Sales Manager:

SYSTRON-DONNER CORPORATION  
CONCORD INSTRUMENT DIVISION  
888 Galindo Street  
Concord, California 94520  
Phone: (415) 682-6161  
TWX: 910-481-9479  
Cable: SYSTRONDONNER

Specify both model and complete serial number in all correspondence.

### 5.2 ASSEMBLY DESIGNATIONS

Table 5.1 lists for reference purposes, information concerning the P.C. board assemblies used in this model.

TABLE 5.1 MODEL 6153-50 ASSEMBLY  
CROSS-REFERENCE INFORMATION

| Ass'y # | Nomenclature              | SD Part # | Schematic # | Page # |
|---------|---------------------------|-----------|-------------|--------|
| A1      | Readout                   | 39383     | 39380       | 7-15   |
| A2      | 3 MHz Osc./<br>Freq. Div. | 39367     | 39364       | 7-17   |
| A3      | 10 MHz Osc.               | 39359     | 39356       | 7-19   |
| A4      | 100 MHz Mult.             | 39363     | 39360       | 7-21   |
| A6      | Attenuator Select         | 39355     | 39352       | 7-23   |
| A7      | Function Select           | 39803     | 39800       | 7-25   |
| A8      | Legend Logic              | 39335     | 39332       | 7-27   |
| A9      | Decimal Logic             | 39339     | 39336       | 7-29   |
| A10     | Time Base                 | 39347     | 39344       | 7-31   |
| A11     | Function Control          | 39343     | 39340       | 7-33   |
| A12     | 200 MHz Decade<br>& Gate  | 39327     | 39324       | 7-35   |

TABLE 5.1 (Cont'd)

| Ass'y # | Nomenclature | SD Part # | Schematic # | Page # |
|---------|--------------|-----------|-------------|--------|
| A13     | Main Power   | 39351     | 39348       | 7-37   |
| A14     | N Computer   | 39375     | 39372       | 7-39   |
| A15     | Shifter      | 39371     | 39368       | 7-41   |
| A16     | 200 MHz Amp. | 39323     | 39320       | 7-43   |
| A18     | 10 MHz Amp.  | 39331     | 39328       | 7-45   |
| A19     | 10 MHz Amp.  | 39331     | 39328       | 7-45   |
| A20     | Mixer/Cable  | 39784     | 27988       | 7-49   |
| A1A2    | BCD Output   | 39379     | 39376       | 7-51   |
| U1      | 3 MHz Osc.   | 33428     | -           | -      |

### 5.3 TEST EQUIPMENT

Table 5.2 lists the minimum test equipment inventory capable of supporting the maintenance of this instrument. In the event these specific items are not available, units of equal, or greater accuracy and capability may be used.

TABLE 5.2 TEST EQUIPMENT  
FOR MODEL 6153-50

| Nomenclature         | Characteristics                           | Recommended Type              |
|----------------------|-------------------------------------------|-------------------------------|
| Freq. Error Expander | Expansion to $10^3$                       | Tracor Model 527A             |
| Oscilloscope         | 80 MHz Bandwidth, plug-in type            | Tektronix Model 581A          |
| Vertical Plug-in     | 10 mV/cm sensitivity                      | Tektronix Model 82            |
| Sampling Plug-in     | DC to 1 GHz                               | Tektronix Model 151           |
| L. F. Generator      | .02 Hz to 2 MHz                           | S-D Model 401                 |
| Sig. Gen.            | 10 Hz to 10 MHz                           | HP Model 651B                 |
| Sig. Gen.            | 10 MHz to 480 MHz                         | HP Model 608C                 |
| Sig. Gen.            | 450 MHz to 1230 MHz                       | HP Model 612A                 |
| Sig. Gen.            | 0.8 GHz to 2.4 GHz                        | HP Model 8614A                |
| Sig. Gen.            | 1.8 GHz to 4.5 GHz                        | HP Model 8616A                |
| Digital Voltmeter    | $\pm 0.1\%$ AC, DC                        | S-D Model 7000A               |
| Freq. Std.           | Stability $< 2 \times 10^{-11}$ per month | General Technology Model 304B |
| Autotransformer      | Variable from 103 V to 127 V ac           | Superior Model UC1M           |

TABLE 5.2 (Cont'd)

| Nomenclature               | Characteristics                   | Recommended Type       |
|----------------------------|-----------------------------------|------------------------|
| Connector                  | BNC "T" (2) req'd                 |                        |
| RF Millivoltmeter          | 1 mV to 3 V, 10 kHz to 2 GHz      | HP Model 411A          |
| Termination (50 $\Omega$ ) | Male to Female BNC                |                        |
| Cable (set)                | BNC to BNC cable;<br>N to N cable | S-D 10338<br>S-D W0094 |
| Electronic Counter         | DC to 200 MHz                     | S-D Model 6153         |
| Pulse Generator            | 35 ns, 0.3 V to 10 V,<br>10 MHz   | S-D Model 101          |

#### 5.4 ASSEMBLY AND CONNECTOR PIN LOCATION

The top and bottom views of the counter are shown in Drawings 39641, 39187, and 39188. Shown are the location of assemblies, chassis parts and connectors. Throughout the test, connections to assemblies are referred to in abbreviated form. For example, a connection to A7 Pin 9 is indicated as A7(9).

#### 5.5 IN-CABINET PERFORMANCE CHECK

The performance test data sheet, Table 5.7 may be used for operational checkout of the instrument. In addition, it may also find usage for incoming inspection tests; as a permanent record of initial performance; as a plan to locate defective parts; for routine calibration records; and, as correlation information after repairs or service.

##### 5.5.1 Rate A Measurements ("A" INPUT Connector)

1) DC Input: Range 0 to 200 MHz, dc-coupled.

a) Set counter controls as follows:

|              |                |
|--------------|----------------|
| FUNCTION     | Rate A         |
| RESOLUTION   | 10 Hz          |
| ATTENUATOR   | X1             |
| DC-AC        | DC             |
| LEVEL        | Preset         |
| SLOW-FAST    | Slow           |
| RECYCLE RATE | Full clockwise |
| TEST         | Deactivated    |

b) Connect various signal generators to cover the range from 0 to 200 MHz. Use "T" connection and monitor with appropriate voltmeter to maintain 100 mV rms at input BNC. Record on data sheet.

c) Connect oscilloscope in place of voltmeter. Connect pulse generator to input, in place of signal generator. Set pulse width to 1  $\mu$ sec, amplitude 300 mV p-p, repetition rate 1 MHz. Change amplitude to 1 V p-p. Use trigger level as required for both amplitudes. Note operation on data sheet.

2) AC Input: Range 10 Hz to 200 MHz, ac-coupled.

a) Repeat procedure described above in DC input, steps a, b, and c with DC-AC switch set in the AC position.

b) Vary generators from 10 Hz to 200 MHz.

c) Record on data sheet.

#### 5.5.2 Rate D Measurements ("D" INPUT Connector)

1) Range: 200 MHz to 3 GHz (CW).

a) Set counter controls as follows:

|              |                |
|--------------|----------------|
| FUNCTION     | 1 kHz          |
| RESOLUTION   | Rate D         |
| SLOW-FAST    | Slow           |
| RECYCLE RATE | Full Clockwise |
| TEST         | Deactivated    |

b) Connect various signal generators to cover the range from 200 MHz to 3 GHz. Maintain 50 mV rms at input to counter. Record on data sheet.

#### 5.5.3 Frequency Resolution ("A" INPUT Connector)

a) Set counter controls as follows:

|              |                |
|--------------|----------------|
| FUNCTION     | Rate A         |
| RESOLUTION   | 1 MHz          |
| ATTENUATOR   | X1             |
| DC-AC        | AC             |
| LEVEL        | Preset         |
| SLOW-FAST    | Slow           |
| RECYCLE RATE | Full Clockwise |
| TEST         | Deactivated    |

b) Connect 10 MHz output from test counter to "A" INPUT of counter under test.

c) Sequentially push each RESOLUTION position from 1 MHz to 0.1 Hz and observe counter readings; record on data sheet.

#### 5.5.4 Test Rate A (Internal Time Base)

- 1) Counts 100 MHz to Resolution selected.
  - a) Use same test procedure indicated in Section 5.5.3, except that TEST pushbutton is activated.
  - b) Sequentially push each RESOLUTION position from 1 MHz to 0.1 Hz and observe counter readings; record on data sheet.

#### 5.5.5 Scaling Measurements ("A" INPUT Connector)

- 1) Range: 0 to 150 MHz (10 through  $10^9$  factors).
  - a) Set counter controls as follows:

|            |                             |
|------------|-----------------------------|
| FUNCTION   | Count A                     |
| RESOLUTION | 10 to $10^9$                |
| ATTENUATOR | X1                          |
| DC-AC      | AC                          |
| LEVEL      | Preset                      |
| TEST       | Deactivated                 |
| OUTPUT     | Rear Panel (T.B. SCALE OUT) |
  - b) Connect output from rear panel T.B. SCALE OUT to an oscilloscope, or another Model 6153-50.
  - c) Connect suitable 150 MHz signal to "A" INPUT". The scaled output when the scale factor 10 pushbutton is pressed will be 15 MHz. The scaled output will decrease by a factor of 10 for each higher order scale increment as shown in Table 5.7. Record on data sheet.

#### 5.5.6 Period and Multiple Period Measurements ("B" INPUT Connector)

- 1) Range : 0 to 10 MHz.
  - a) Set counter controls as follows:

|              |                |
|--------------|----------------|
| FUNCTION     | Per Ratio X1   |
| RESOLUTION   | 10 ns          |
| ATTENUATOR   | X1             |
| DC-AC        | AC             |
| LEVEL        | Preset         |
| SLOW-FAST    | Slow           |
| RECYCLE RATE | Full clockwise |
| SLOPE        | Positive (+)   |
| SEP-COM      | Sep            |
| TEST         | Deactivated    |



- b) Connect 10 MHz output of test counter to "B" INPUT.
- c) Set FUNCTION switch to P/RX1,  $\times 10^2$ ,  $\times 10^3$ ,  $\times 10^4$ , and  $\times 10^5$ . Observe all positions and record the results.
- d) Connect T.B. SCALE OUTPUT of test counter to "B" INPUT. Turn RECYCLE RATE control of test counter to infinite position, and push 1 Hz RESOLUTION pushbutton. This will deliver a 1 Hz signal to the counter under test.
- e) Sequentially push each RESOLUTION position from 10 ns to 1 sec. Observe and record the results on the data sheet.

*NOTE: Observed readout accuracy will be a function of trigger level, frequency difference between counters, and  $\pm 1$  count error.*

#### 5.5.7 Ratio and Multiple Ratio Measurements ("A" and "B" INPUT Connectors)

- 1) Range: "A" INPUT dc to 200 MHz; "B" INPUT 0 to 10 MHz. The "A" INPUT is used for the higher frequency (numerator); the "B" INPUT is for the lower frequency (denominator).

- a) Set counter controls as follows:

|                |                |
|----------------|----------------|
| FUNCTION       | P/R            |
| RESOLUTION     | Ratio A/B      |
| "A" ATTENUATOR | X1             |
| "A" DC-AC      | AC             |
| "A" LEVEL      | Preset         |
| "B" ATTENUATOR | X1             |
| "B" DC-AC      | AC             |
| "B" LEVEL      | Preset         |
| SEP-COM        | Sep            |
| SLOW-FAST      | Slow           |
| RECYCLE RATE   | Full clockwise |
| TEST           | Deactivated    |

- b) Connect 200 MHz signal at 100 mV rms to "A" INPUT, from suitable generator.
- c) Connect "B" INPUT of counter under test to T.B. SCALE OUT of the test counter. Push 100 kHz RESOLUTION button on the test counter for tests (1), (2), and (3) below. Push 100 Hz RESOLUTION button for remainder of tests. Monitor with oscilloscope.

- d) Observe and record ratio of A/B by changing the inputs to "A" and "B" as follows:

TABLE 5.3 TEST #1, RATIO MEASUREMENTS

| TEST # | "A" INPUT | "B" INPUT | RATIO A/B READOUT |
|--------|-----------|-----------|-------------------|
| (1)    | 200 MHz   | 100 kHz   | 00002000.         |
| (2)    | 100 MHz   | 100 kHz   | 00001000.         |
| (3)    | 50 MHz    | 100 kHz   | 00000500.         |
| (4)    | 10 MHz    | 100 Hz    | 00100000.         |
| (5)    | 1 MHz     | 100 Hz    | 00010000.         |
| (6)    | 100 kHz   | 100 Hz    | 00001000.         |
| (7)    | 10 kHz    | 100 Hz    | 00000100.         |
| (8)    | 1 kHz     | 100 Hz    | 00000010.         |
| (9)    | 100 Hz    | 100 Hz    | 00000001.         |

- e) Change FUNCTION switch and test counter frequencies as indicated below. Record on data sheet.

TABLE 5.4 TEST #2,  
MULTIPLE RATIO MEASUREMENTS

| TEST # | "A" INPUT | "B" INPUT | FUNCTION                   | RATIO A/B READOUT* |
|--------|-----------|-----------|----------------------------|--------------------|
| (1)    | 200 MHz   | 100 kHz   | Per-Ratio X10              | 0002000.0          |
| (2)    | 100 MHz   | 100 kHz   | Per-Ratio X10 <sup>2</sup> | 001000.00          |
| (3)    | 50 MHz    | 10 kHz    | Per-Ratio X10 <sup>3</sup> | 05000.000          |
| (4)    | 100 MHz   | 10 MHz    | Per-Ratio X10 <sup>4</sup> | 0010.0000          |
| (5)    | 200 MHz   | 1 MHz     | Per-Ratio X10 <sup>5</sup> | 200.00000          |

*\*NOTE: Readout accuracy will be a function of signal generator resolution, stability, and trigger level accuracy.*

#### 5.5.8 Time Interval Measurements ("B" and "C" INPUT Connectors)

- 1) Range: 100 ns to 10<sup>8</sup> seconds (10 ns to 1 second).

- a) Set counter controls as follows:

|                |         |
|----------------|---------|
| FUNCTION       | TIM B-C |
| RESOLUTION     | 10 ns   |
| "B" ATTENUATOR | X1      |
| "B" DC-AC      | AC      |

|                |                |
|----------------|----------------|
| "B" LEVEL      | Preset         |
| "B" SLOPE      | (+)            |
| "C" ATTENUATOR | X1             |
| "C" DC-AC      | AC             |
| "C" LEVEL      | Preset         |
| "C" SLOPE      | (+)            |
| SEP-COM        | Com            |
| SLOW-FAST      | Slow           |
| RECYCLE RATE   | Full clockwise |
| TEST           | Deactivated    |

- b) With a BNC "T" connector, connect output of pulse generator to "B" INPUT (Start), and oscilloscope monitor.
  - c) Adjust pulse generator for a 10 MHz repetition rate, 50% duty cycle, 0.3 V p-p. Gate light will be energized and display will read 000000.10  $\mu$ s  $\pm$ 1 count. Record on data sheet.
  - d) Adjust pulse generator for a 5 MHz repetition rate, 50% duty cycle, 0.3 V p-p. Counter will display 000000.20  $\mu$ s  $\pm$ 1 count. Record on data sheet.
  - e) Change "C" INPUT (Stop) SLOPE to minus (-). Counter will display 000000.10  $\mu$ s  $\pm$ 1 count. Record on data sheet.
  - f) Change "B" INPUT (Start) SLOPE to minus(-), "C" INPUT (Stop) SLOPE to plus (+). Counter will display 000000.10  $\mu$ s  $\pm$ 1 count. Record on data sheet.
  - g) Change "C" INPUT (Stop) SLOPE to minus (-). Counter will display 000000.20  $\mu$ s  $\pm$ 1 count. Record on data sheet.
- 2) Sensitivity: Start and Stop, 0.3 V p-p.

- a) Set counter controls as follows:

|                |         |
|----------------|---------|
| FUNCTION       | TIM B-C |
| RESOLUTION     | 10 ns   |
| "B" ATTENUATOR | X1      |
| "B" DC-AC      | AC      |
| "B" LEVEL      | Preset  |
| "B" SLOPE      | (+)     |
| "C" ATTENUATOR | X1      |
| "C" DC-AC      | AC      |

|              |                |
|--------------|----------------|
| "C" LEVEL    | Preset         |
| "C" SLOPE    | (-)            |
| SEP-COM      | Com            |
| SLOW-FAST    | Slow           |
| RECYCLE RATE | Full clockwise |
| TEST         | Deactivated    |

- b) Interconnect equipment as shown in Figure 5.1. Set test oscillator for 0.3 V p-p, 1 kHz sine wave.
  - c) Adjust oscilloscope for waveform shown in Figure 5.2. The intensity marker on the first graticule (positive-going) is the Start marker. The intensity marker on the second graticule is the Stop marker.
  - d) Decrease the oscillator output until the markers disappear. Note the peak-to-peak voltage at which the markers disappear. Record this level on the data sheet (must be  $\leq 0.3$  V p-p).
- 3) Trigger Level: Each channel must be continuously adjustable  $\pm 3.0$  V, or more, times the attenuator factor.

- a) Set counter controls as follows:

|                |                |
|----------------|----------------|
| FUNCTION       | TIM B-C        |
| RESOLUTION     | 10 ns          |
| "B" ATTENUATOR | X1             |
| "B" DC-AC      | AC             |
| "B" LEVEL      | Preset         |
| "B" SLOPE      | (+)            |
| "C" ATTENUATOR | X1             |
| "C" DC-AC      | AC             |
| "C" LEVEL      | Preset         |
| "C" SLOPE      | (+)            |
| SEP-COM        | Sep            |
| SLOW-FAST      | Slow           |
| RECYCLE RATE   | Full clockwise |
| TEST           | Deactivated    |

- b) Interconnect equipment as shown in Figure 5.1. Set oscillator for 8 V p-p, 1 kHz sine wave.
- c) Adjust oscilloscope to waveform shown in Figure 5.3.
- d) Rotate the "B" LEVEL control to the maximum CW position. Marker should appear at a level of +3 volts or greater.

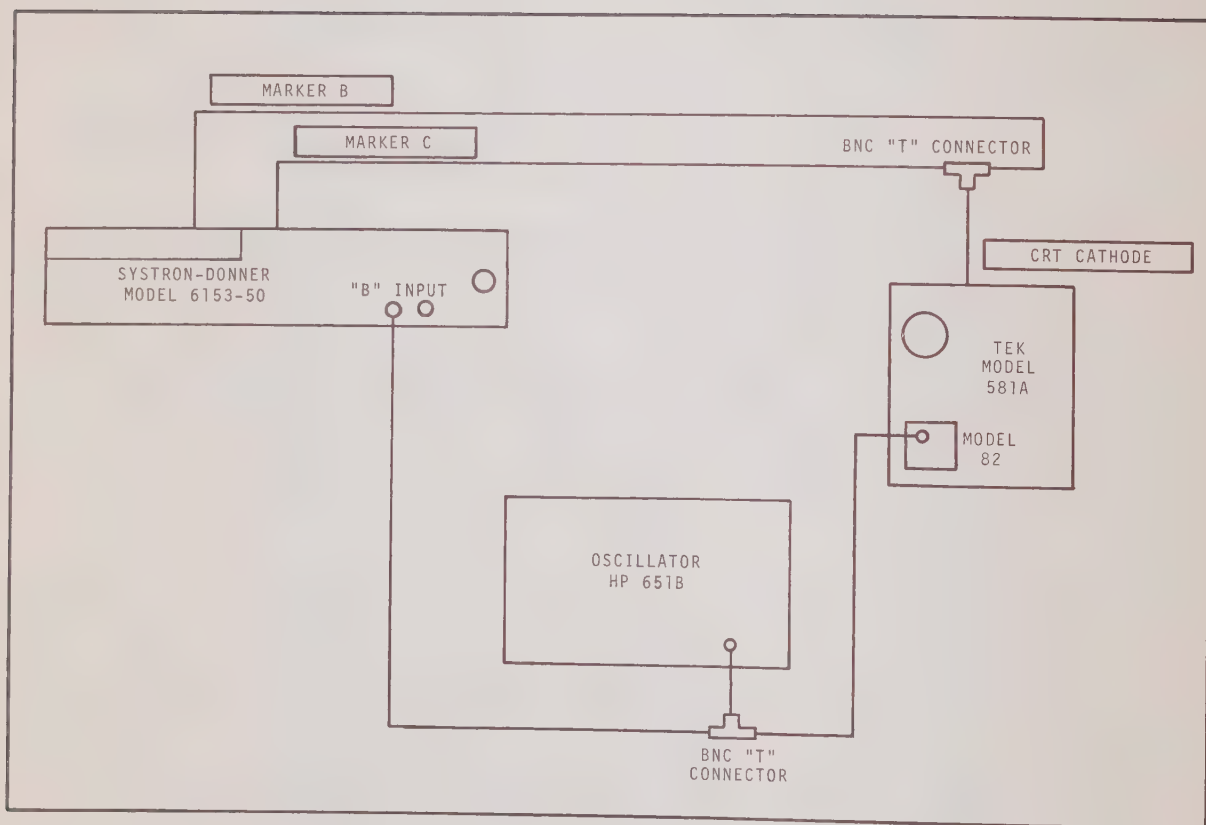
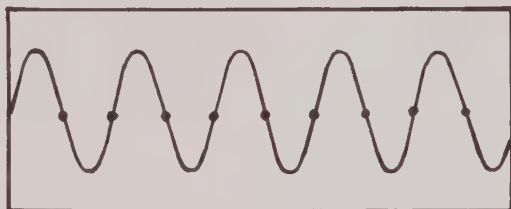


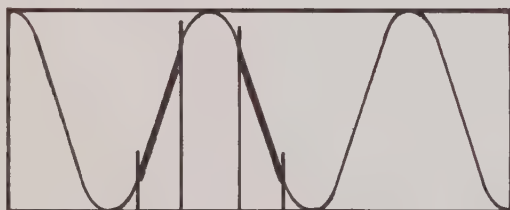
FIGURE 5.1 "B" AND "C" TRIGGER LEVEL/MARKER SENSITIVITY TEST SET UP.





OSCILLOSCOPE SETTINGS  
 VERTICAL: 100 mV/div.  
 HORIZONTAL: 0.5 ms/div.

FIGURE 5.2 "B" AND "C" MARKER INTENSITY CHECK.



OSCILLOSCOPE SETTINGS  
 VERTICAL: 1.0 V/div.  
 HORIZONTAL: 0.25 ms/div.

→    ←  
 +    -  
 SLOPE SLOPE

FIGURE 5.3 "B" AND "C" SLOPE/MARKER WAVEFORM CHECK.

- e) Rotate the "B" LEVEL control to the maximum CCW position, but not into Preset. Marker should appear at a level of -3 volts or greater. Record on data sheet.
- f) Change "B" SLOPE to minus (-). Repeat steps (d) and (e). Marker will now appear on negative slope of sine wave signal. Record on data sheet.
- g) Remove signal from "B" INPUT and connect to "C" INPUT.
- h) Repeat steps (d) through (f) and record on data sheet.

#### 5.5.9 Time Base: (Internal Frequency)

##### 1) Temperature Stability:

- a) Connect measurement system as shown in Figure 5.4, set counter controls as follows:

##### Test Counter Set-Up:

|                |                |
|----------------|----------------|
| FUNCTION       | Rate A         |
| RESOLUTION     | .1 Hz          |
| "A" ATTENUATOR | X10            |
| "A" DC-AC      | AC             |
| "A" LEVEL      | Preset         |
| FAST-SLOW      | Slow           |
| RECYCLE RATE   | Full clockwise |
| TEST           | Deactivated    |

##### Oscillator Under Test:

|              |             |
|--------------|-------------|
| FUNCTION     | Rate A      |
| RESOLUTION   | 1 MHz       |
| RECYCLE RATE | Infinity    |
| TEST         | Deactivated |

- b) Place counter to be tested in a temperature-controlled environment.
- c) Stabilize counter at 25° C ambient for 72 hours.
- d) Calibrate the counter oscillator to the frequency standard by adjusting the coarse and fine adjust, as required, to produce a reading of 1000000.0 Hz,  $\pm 10$  counts. The least significant digit represents one part in  $10^{10}$ . Record the absolute value obtained as a reference frequency.

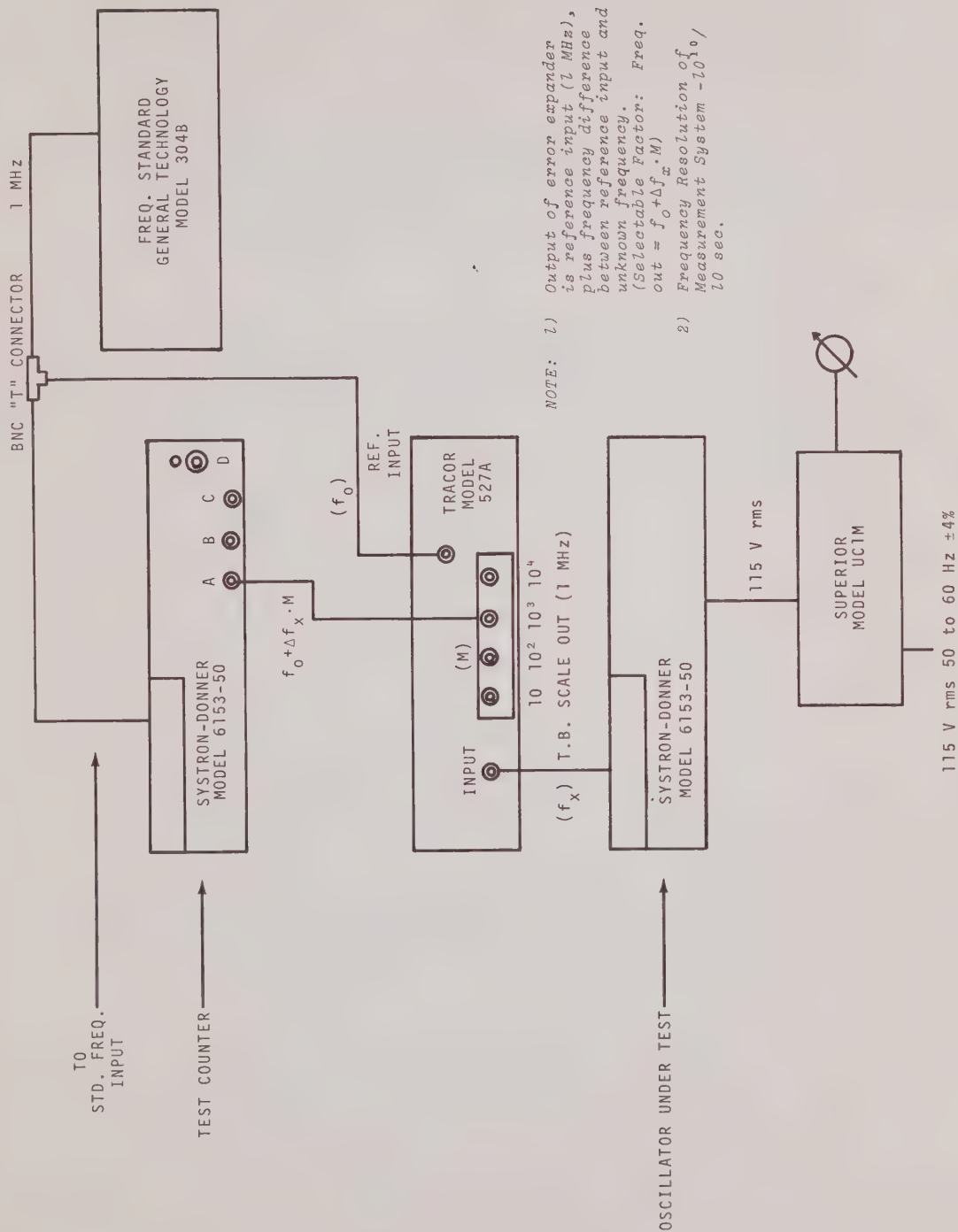


FIGURE 5.4 TIME BASE TEMPERATURE STABILITY CHECK.

- e) Lower the temperature to  $-10^{\circ}\text{C}$  and allow 3.5 hours to stabilize. Record observed frequency. Elevate the temperature to  $+50^{\circ}\text{C}$  and allow 3.5 hours to stabilize. Record observed frequency. Lower the temperature to  $25^{\circ}\text{C}$  and allow to stabilize.
- 2) Line-Voltage Stability:
    - a) Set line voltage to counter under test, to 115 V rms with variable-voltage ac source while maintaining a stable environment. Record observed frequency. Reduce line voltage to 103 V rms and record observed frequency. Raise line voltage to 127 V rms and record observed frequency.
  - 3) Long-Term Stability:
    - a) Maintain constant environment and line voltage. Be certain that counter has been allowed 72 hours to stabilize. Record reference frequency. Record frequency 24 hours later.
  - 4) Time Base Output:
    - a) Set counter controls as follows:
 

|                        |                |
|------------------------|----------------|
| FUNCTION               | Rate A         |
| RESOLUTION             | As selected    |
| RECYCLE RATE           | Full clockwise |
| TEST                   | Deactivated    |
| EXT/INT TIME BASE      | Internal       |
| EXT/INT STD FREQ INPUT | Internal       |
    - b) Connect oscilloscope to the T.B. SCALE OUTPUT; signal observed, in each instance, should be the frequency selected by the RESOLUTION switch, over the range, in decade steps, from 0.1 Hz to 10 MHz, at an amplitude of 1.0 V p-p (TTL output).
    - c) Connect oscilloscope to 10 MHz OUTPUT. Observe and record with the oscilloscope, a 10 MHz signal at an amplitude of 1.0 V p-p.

## 5.6 TROUBLESHOOTING PROCEDURES

- 1) If the instrument fails to operate, check the following items:
  - a) Be certain that line power is available to the instrument.
  - b) Check line-change switch to be sure it is in proper position for available line voltage.
  - c) Be sure that main power fuse is not defective.
  - d) Check main power switch for continuity.

- e) Be certain that the power supplies are properly energized and that the output of each meets the specifications given in Section 5.11.
- 2) Instrument does not perform correctly in TEST.
- a) Set counter to operate in accordance with procedures given in Section 3.5.
  - b) Use the following Tables, in sequence, to locate the defective assembly. In the indicated switch conditions; if an incorrect reading is shown, the possible defective assembly number is noted.

TABLE 5.5 TEST #1,  
FREQUENCY TROUBLESHOOTING CHART

| TEST ON | RESOLUTION | FUNCTION | POSSIBLE ASSEMBLY # FAILURE |
|---------|------------|----------|-----------------------------|
| Yes     | 1 MHz      | Rate A   | A12,A11,A10,A1,A4,A3,A2,U1  |
| Yes     | 100 kHz    | Rate A   | A10,A1                      |
| Yes     | 10 kHz     | Rate A   | A10,A1                      |
| Yes     | 1 kHz      | Rate A   | A10,A1                      |
| Yes     | 100 Hz     | Rate A   | A10,A1                      |
| Yes     | 10 Hz      | Rate A   | A10,A1                      |
| Yes     | 1 Hz       | Rate A   | A10,A1                      |
| Yes     | 0.1 Hz     | Rate A   | A10,A1                      |
| Yes     | 1 MHz      | Rate D   | A14,A11,A12                 |

TABLE 5.6 TEST #2,  
PERIOD TROUBLESHOOTING CHART

| TEST ON | RESOLUTION | FUNCTION             | POSSIBLE ASSEMBLY # FAILURE |
|---------|------------|----------------------|-----------------------------|
| Yes     | 10 ns      | Per X1               | A11,A12,A10                 |
| Yes     | 10 ns      | Per X10              | A10                         |
| Yes     | 10 ns      | Per X10 <sup>2</sup> | A10                         |
| Yes     | 10 ns      | Per X10 <sup>3</sup> | A10                         |
| Yes     | 10 ns      | Per X10 <sup>4</sup> | A10                         |
| Yes     | 10 ns      | Per X10 <sup>5</sup> | A10                         |

- c) If trouble occurs during operation in the Rate A function, check assembly A16.
- d) If trouble occurs during operation in the TIM function, check assemblies A18, A19.



- e) If trouble occurs during operation in the Rate D function, check assemblies A20, A15, and A14.
- f) If the high stability oscillator does not calibrate correctly, check assemblies A2, A3, and nonrepairable oscillator assembly U1.
- g) If trouble occurs with decimal operation, check assembly A8.
- h) If trouble occurs with the measurement unit annunciator, check assembly A9.
- i) If trouble occurs with BCD output operation, check assemblies A1, A11, A12, and A1A2.

## 5.7 INSTRUMENT COVER REMOVAL

- 1) Top cover - Remove the two flush-mounted screws which are exposed on the top cover. Slide the cover to the rear and lift upwards.
- 2) Bottom cover - Remove the two flush-mounted screws which are located toward the two edges of the cover. Slide the cover to the rear and lift upwards.

## 5.8 ASSEMBLY LOCATION

Modular assemblies and major components are shown in Assembly Drawing 39641.

## 5.9 PRINTED CIRCUIT BOARD REMOVAL

- 1) A1 Readout: Disconnect the two cables from the assembly, remove the two screws securing BCD output assembly A1A2, and unplug from assembly A1. Remove the screws holding assembly A1 in place and lift the board upwards and toward the rear of the instrument.
- 2) A20 Mixer: Unplug the cable from assembly A15. Remove the two screws located on the front panel above and below the Rate "D" INPUT connector. The assembly will move to the rear and upward for removal.
- 3) All other board assemblies are removed directly upward after first actuating the board lifters.

## 5.10 PRINTED CIRCUIT BOARD REPAIR

When replacing integrated circuits or other electronic components soldered to printed-circuit boards, the procedures indicated below must be followed or damage to the board may result:

- 1) Determine by troubleshooting techniques, which integrated circuit or discrete component(s) has failed.

- 2) Remove the defective component(s) from the board by cutting the pins or leads with a small diagonal clipping tool. (Always remove and replace the entire component.)
- 3) Apply heat (40-50 W soldering iron) sparingly to each of the cut pins or leads and remove from the board; clean the hole(s) with a toothpick or solder suction tool.
- 4) Form the tinned leads of the replacement part and insert in the printed circuit holes; solder, then trim leads to extend 1/16-inch beyond the back surface of the board. (Use only 63-37 solder with maximum 1/16-inch diameter.)

#### CAUTION

*Always trim semiconductor leads only after soldered installation is complete. This procedure greatly lessens the possibility of component failure due to shock-wave damage caused by the trimming tool.*

- 5) When soldering semiconductor devices and all small components, be sure to use a heat sink tool or long-nosed plier connected to the component lead(s) while each is being soldered. Allow the soldered connection to cool before removing the heat sink.
- 6) Clean all dirt and solder-flux from the printed circuit traces by liberal application of isopropyl alcohol or freon-type solvents.

### 5.11 CIRCUIT ADJUSTMENTS

Adjustments to instrument circuits must be made in the order shown; however, these should not be made unless a trouble has been found which definitely indicates the need for such an adjustment(s). All voltages, unless noted, are referenced to the chassis.

- 1) Main Power - Assembly A13 (Set line voltage to 115 V or 230 V ac.)
  - a) Measure voltage on positive lug of capacitor C3 and read +225,  $\pm 20$  V. No adjustment is available, however, this voltage must be checked.
  - b) Measure +12.0,  $\pm 0.1$  V at the +12 V Test Point on assembly A13. If the voltage is in error, adjust +12 V adj control on the same board.
  - c) Measure -12.0,  $\pm 0.1$  V at the -12 V Test Point on assembly A13. If voltage is in error adjust -12 V adj control on the same board.
  - d) Measure +5.00,  $\pm 0.05$  V at the +5 V Test Point on assembly A13. If the voltage is in error adjust the +5 V adj control on the same board.

- e) Measure  $-5.20, \pm 0.05$  V at the  $-5.2$  V Test Point on assembly A13. If the voltage is in error adjust the  $-5.2$  V adj control on the same board.
- 2) 3 MHz Oscillator Power - Assembly A2 (Instrument should be "on" at least 15 minutes)
- a) Measure  $+28.0, \pm 2.0$  V at A2 (E).
- 3) 10 MHz Oscillator - Assembly A3 (ambient temperature  $25^{\circ}$  C  $\pm 5^{\circ}$  C)
- a) Set the EXTERNAL/INTERNAL STD FREQ INPUT switch to EXTERNAL. DO NOT inject an external frequency.
  - b) Connect A3 (TP1) to ground.
  - c) Synchronize the oscilloscope to an external frequency standard. Connect the 10 MHz output of the counter under test to the vertical amplifier of the oscilloscope.
  - d) Adjust A3 C2 for a stable trace on the oscilloscope.
  - e) Remove ground from A3 (TP1) and adjust A3 R23 for stable trace on oscilloscope.
  - f) Return instrument to normal operation.
- 4) 100 MHz Multiplier - Assembly A4
- a) Measure with oscilloscope at A4 (22); check for a 100 MHz signal with  $\geq 1$  V p-p amplitude. If frequency or voltage is out of specification, proceed to steps b) through d).
  - b) Check A4 (3) for a 1.0 MHz signal with an amplitude between 2 V and 5 V p-p.
  - c) Observe A4 (22); adjust A2 C11, A2 C12, A2 C15, and A2 C16 until a maximum-amplitude 100 MHz signal is obtained.  
  
*NOTE: If A2 C10 and A2 C12 are badly misadjusted, an improper 60 MHz signal may be obtained.*
  - d) Repeat step c) until maximum amplitude is obtained, taking care that A2 C16 is the last adjustment in the sequence.
- 5) 10 MHz Amplifier - Assemblies A18 and A19 (LEVEL in Preset, ATTENUATOR X1, SEP-COM switch to COM.)
- a) Connect test oscillator to "B" INPUT. Adjust output of oscillator for 100 mV rms, at 100 kHz.
  - b) Connect "B" MARKER output J9 to input of oscilloscope.
  - c) Observe "B" MARKER output while reducing oscillator input signal level and adjust A18 R7 for best sensitivity.

- d) Connect "C" MARKER output J10 to input of oscilloscope.
  - e) Observe "C" MARKER output while reducing oscillator input signal level and adjust A19 R7 for best sensitivity.
- 6) 200 MHz Amplifier - Assembly A16 (LEVEL in Preset, ATTENUATOR X1)
- a) With voltmeter, balance the differential pair Q1A and B and Q3-Q4 by adjusting R9. Balance should be within 20 millivolts. Measure balance at R29 and R32.
  - b) Connect test oscillator to "A" INPUT. Adjust R13 to provide best sensitivity at 200 MHz when in the COUNT A mode.
  - c) Disconnect input signal and confirm balance at R29 and R32. Readjust R9 and repeat (b).
- 7) Mixer - Assembly A20
- a) Turn FUNCTION switch to RATE D and RESOLUTION switch to 10 kHz (no connection to "D" INPUT).
  - b) Adjust A20 R17 for  $\pm 0.00$  V at lug A20-C, the output of U1.
  - c) Observe A15 TP1 for symmetrical sawtooth waveform. Adjust A15 R55 to mid-position.
  - d) Connect a 3.0 GHz signal to the "D" INPUT. Set the input level to -15 dBm. Measure the junction of A20 R36 and A20 R19, and set the reading on this junction to -1.75 V with A20 R19.
  - e) Adjust A15 R55 to provide correct frequency indication with the least clockwise rotation (minimum gain).

## 5.12 CALIBRATION

The 3 MHz oscillator is the only component in the instrument requiring routine calibration in order to maintain best accuracy and performance. A periodic check-out/adjustment of oscillator frequency is a necessary requirement for normal operation, and especially when high accuracy is demanded. When calibration is required, be sure that the instrument has been "on" and operating for 72 hours continuously.

- a) Connect the test frequency standard (traceable to N.B.S.) to the external trigger input of the oscilloscope. Connect the 10 MHz OUTPUT J7 to the input of the oscilloscope. Set the horizontal sweep rate to 10 ns/cm.
- b) Set the fine/coarse frequency adjust on the oscillator, as required, to produce a stationary waveform.
- c) If the waveform moves at a rate of 1 centimeter per second, the two frequencies are within  $\pm 1$  part in  $10^8$  of each other. A rate of 1 centimeter per 10 second period indicates that the two frequencies are within  $\pm 1$  part in  $10^9$  of each other.

Date of Test: \_\_\_\_\_  
Test Performed By: \_\_\_\_\_

## ACTUAL PERFORMANCE CHECK



TABLE 5-7 (Cont'd)  
PERFORMANCE DATA SHEET

| TEST OPERATION |                                                                                               | ACTUAL PERFORMANCE CHECK |     |
|----------------|-----------------------------------------------------------------------------------------------|--------------------------|-----|
| 5.5.4          | Test - Rate A                                                                                 |                          |     |
|                | Counts 100 MHz                                                                                |                          |     |
|                | RESOLUTION SWITCH POSITION                                                                    |                          |     |
|                | 1 MHz                                                                                         | 00000100                 | MHz |
|                | 100 kHz                                                                                       | 0000100.0                | MHz |
|                | 10 kHz                                                                                        | 000100.00                | MHz |
|                | 1 kHz                                                                                         | 00100000                 | kHz |
|                | 100 Hz                                                                                        | 0100000.0                | kHz |
| 5.5.5          | Scaling Measurements                                                                          |                          |     |
|                | "A" Input Frequency                                                                           |                          |     |
|                | 150 MHz                                                                                       |                          |     |
|                | SCALE FACTOR                                                                                  |                          |     |
| 5.5.5          | 10                                                                                            | 15                       | MHz |
|                | 10 <sup>2</sup>                                                                               | 1.5                      | MHz |
|                | 10 <sup>3</sup>                                                                               | 150                      | kHz |
|                | 10 <sup>4</sup>                                                                               | 15                       | kHz |
|                | 10 <sup>5</sup>                                                                               | 1.5                      | kHz |
|                | 10 <sup>6</sup>                                                                               | 150                      | Hz  |
|                | 10 <sup>7</sup>                                                                               | 15                       | Hz  |
|                | 10 <sup>8</sup>                                                                               | 1.5                      | Hz  |
|                | 10 <sup>9</sup>                                                                               | .15                      | Hz  |
|                |                                                                                               |                          |     |
| 5.5.6          | Period and Multiple Period Measurements                                                       |                          |     |
|                | 1) Frequency input 10 MHz; RESOLUTION switch to 10 ns.<br>2) Change FUNCTION switch as shown: |                          |     |

TABLE 5-7 (Cont'd)  
PERFORMANCE DATA SHEET

| TEST OPERATION                                                                                           |                                                   | ACTUAL PERFORMANCE CHECK |         |
|----------------------------------------------------------------------------------------------------------|---------------------------------------------------|--------------------------|---------|
| 5.5.6                                                                                                    | Period and Multiple Period Measurements (Cont'd)  |                          |         |
|                                                                                                          | FUNCTION SWITCH POSITION                          |                          |         |
| NOTE: Accuracy depends on $\pm$ trigger error, $\pm 1$ count, $\pm$ frequency difference of oscillators. | Period X1                                         | 000000.10                | $\mu$ s |
|                                                                                                          | Period X10                                        | 00000.100                | $\mu$ s |
|                                                                                                          | Period X10 <sup>2</sup>                           | 0000.1000                | $\mu$ s |
|                                                                                                          | Period X10 <sup>3</sup>                           | 000.10000                | $\mu$ s |
|                                                                                                          | Period X10 <sup>4</sup>                           | 00.100000                | $\mu$ s |
|                                                                                                          | Period X10 <sup>5</sup>                           | 0.1000000                | $\mu$ s |
| 3)                                                                                                       | Frequency input 1 Hz; FUNCTION switch, Period X1. |                          |         |
| 4)                                                                                                       | Change RESOLUTION switches as shown:              |                          |         |
|                                                                                                          | RESOLUTION SWITCH POSITION                        |                          |         |
| NOTE: Accuracy depends on $\pm$ trigger error, $\pm 1$ count, $\pm$ frequency difference of oscillators. | 10 ns                                             | (1)000000.00             | $\mu$ s |
|                                                                                                          | 100 ns                                            | 1000000.0                | $\mu$ s |
|                                                                                                          | 1 ns                                              | 01000000                 | $\mu$ s |
|                                                                                                          | 10 $\mu$ s                                        | 001000.00                | ms      |
|                                                                                                          | 100 $\mu$ s                                       | 0001000.0                | ms      |
|                                                                                                          | 1 ms                                              | 00001000                 | ms      |
|                                                                                                          | 10 ms                                             | 000001.00                | s       |
|                                                                                                          | 100 ms                                            | 0000001.0                | s       |
|                                                                                                          | 1 s                                               | 00000001(.)              | s       |
|                                                                                                          | 10 s                                              | *                        | *       |

6153-50.3.71

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TABLE 5-7 (Cont'd)  
PERFORMANCE DATA SHEET

| TEST OPERATION |                                                                                                            | ACTUAL PERFORMANCE CHECK                       |                           |
|----------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------|---------------------------|
| 5.5.8          | Time Interval Measurements                                                                                 | NOTE: All reading allowed $\pm 1$ count error. |                           |
|                | 1) Range: 100 ns to $10^8$ seconds.                                                                        |                                                |                           |
|                | START "B" SLOPE                                                                                            | STOP "C" SLOPE                                 | COM INPUT "B" & "C"       |
|                | +                                                                                                          | +                                              | 10 MHz                    |
|                | +                                                                                                          | +                                              | 5 MHz                     |
|                | +                                                                                                          | -                                              | 5 MHz                     |
|                | -                                                                                                          | +                                              | 5 MHz                     |
|                | -                                                                                                          | -                                              | 5 MHz                     |
|                |                                                                                                            |                                                | 000000.10 $\mu$ s         |
|                |                                                                                                            |                                                | 000000.20 $\mu$ s         |
| 5.5.9          | 2) Sensitivity:                                                                                            |                                                | 000000.10 $\mu$ s         |
|                | Both markers disappear at:                                                                                 |                                                | 000000.20 $\mu$ s         |
|                | 3) Trigger Level: $\pm 3.0$ V X attenuation factor                                                         |                                                | 000000.10 $\mu$ s         |
|                |                                                                                                            |                                                | 000000.10 $\mu$ s         |
|                | "B" INPUT                                                                                                  | Start +                                        | Level CW                  |
|                |                                                                                                            | Start +                                        | Level CCW                 |
|                |                                                                                                            | Start -                                        | Level CW                  |
|                |                                                                                                            | Start -                                        | Level CCW                 |
|                | "C" INPUT                                                                                                  | Stop +                                         | Level CW                  |
|                |                                                                                                            | Stop +                                         | Level CCW                 |
| 5.5.9          | Time Base                                                                                                  | Stop -                                         | Level CW                  |
|                | 1) Temperature Stability ( $\pm 2 \times 10^{10}$ / $^{\circ}$ C from $-10^{\circ}$ C to $+50^{\circ}$ C): | Stop -                                         | Level CCW                 |
|                |                                                                                                            |                                                | > +3.0 V                  |
|                |                                                                                                            |                                                | > -3.0 V                  |
|                |                                                                                                            |                                                | > +3.0 V                  |
|                |                                                                                                            |                                                | > -3.0 V                  |
|                |                                                                                                            |                                                | > +3.0 V                  |
|                |                                                                                                            |                                                | > -3.0 V                  |
|                |                                                                                                            |                                                | > +3.0 V                  |
|                |                                                                                                            |                                                | > -3.0 V                  |
| 5.5.9          | Reference frequency                                                                                        |                                                | 1000000.0 $\pm 10$        |
|                | -10 $^{\circ}$ C frequency                                                                                 |                                                | Reference $\pm 70$ counts |
|                | +50 $^{\circ}$ C frequency                                                                                 |                                                | Reference $\pm 50$ counts |
|                |                                                                                                            |                                                |                           |

TABLE 5-7 (Cont'd)  
PERFORMANCE DATA SHEET

| TEST OPERATION |                                                                         | ACTUAL PERFORMANCE CHECK |                           |
|----------------|-------------------------------------------------------------------------|--------------------------|---------------------------|
| 5.5.9          | Time Base (Cont'd)                                                      |                          |                           |
|                | 2) Line Voltage ( $\pm 5 \times 10^{10}$ for a $\pm 10\%$ line change): |                          |                           |
|                | Reference frequency                                                     |                          | Reference $\pm 5$ counts  |
|                | -10% line (103 V ac)                                                    |                          | Reference $\pm 5$ counts  |
|                | +10% line (127 V ac)                                                    |                          |                           |
|                | 3) Long-term stability ( $\pm 3 \times 10^9/24$ hours):                 |                          |                           |
|                | Reference frequency                                                     |                          | Reference $\pm 30$ counts |
|                | 24 hours later                                                          |                          |                           |
|                | 4) Time Base Output (1.0 V p-p from 10 MHz to 0.1 Hz):                  |                          |                           |
|                | RESOLUTION                                                              |                          |                           |
|                | SWITCH                                                                  |                          |                           |
|                | POSITION                                                                |                          |                           |
|                | 100 ns                                                                  | 10 MHz,                  | $> 1.0$ V p-p             |
|                | 1 MHz                                                                   | 1 MHz                    | $> 1.0$ V p-p             |
|                | 100 kHz                                                                 | 100 kHz,                 | $> 1.0$ V p-p             |
|                | 10 kHz                                                                  | 10 kHz,                  | $> 1.0$ V p-p             |
|                | 1 kHz                                                                   | 1 kHz,                   | $> 1.0$ V p-p             |
|                | 100 Hz                                                                  | 100 Hz,                  | $> 1.0$ V p-p             |
|                | 10 Hz                                                                   | 10 Hz,                   | $> 1.0$ V p-p             |
|                | 1 Hz                                                                    | 1 Hz,                    | $> 1.0$ V p-p             |
|                | 0.1 Hz                                                                  | 0.1 Hz,                  | $> 1.0$ V p-p             |
|                | 5) 10 MHz Output:                                                       |                          |                           |
|                |                                                                         | 10 MHz,                  | $> 1.0$ V p-p             |





CHAPTER 6  
FINAL ASSEMBLY PARTS LIST

| REF.    | DESCRIPTION                             | SD<br>PART NO. | QTY. |
|---------|-----------------------------------------|----------------|------|
|         | Model 6153-50 Block Diagram             | F39384         |      |
| 10      | Test Assembly                           | D39641         | 1    |
| 12      | Bottom Cover Assembly                   | C39644         | 1    |
| 14      | Top Cover                               | D33760-4       | 1    |
| 16      | Side Cover                              | C33764-4       | 2    |
| 18      | End Trim                                | C33693         | 4    |
| 20      | Side Trim                               | C33564-4       | 2    |
| 22      | Handle                                  | C33570-4       | 2    |
| 24      | Side Trim, Top                          | 39859-4        | 2    |
| 26      | Nut, Tinnerman                          | H1907          | 4    |
| 28      | Connector w/Hood, 50 Pin                | J0170          | 1    |
| 21      | Mother Board P.C. Assembly              | 39114          | 1    |
| 22      | Rear Panel Assembly                     | D39187         | 1    |
| 23      | Front Panel Assembly                    | D39188         | 1    |
| 24      | Power Supply Chassis Assembly           | D39189         | 1    |
| U1      | 3 MHz Oscillator Assembly               | B33428         | 1    |
| AlA1    | Annunciator Assembly                    | C39186         | 1    |
| AlA2    | BCD Output P.C. Assembly                | B39379         | 1    |
| Al      | Readout P.C. Assembly                   | C39383         | 1    |
| A2      | 3 MHz Oscillator Power P.C.<br>Assembly | B39367         | 1    |
| A3      | 10 MHz Oscillator P.C. Assembly         | B39359         | 1    |
| A4      | 100 MHz Mult. P.C. Assembly             | B39363         | 1    |
| A6      | Attenuator Select P.C. Assembly         | B39355         | 1    |
| A7      | Function Select P.C. Assembly           | B39803         | 1    |
| A8      | Legend Logic P.C. Assembly              | B39335         | 1    |
| A9      | Decimal Logic P.C. Assembly             | C39339         | 1    |
| Al0     | Time Base P.C. Assembly                 | C38347         | 1    |
| Al1     | Function Control P.C. Assembly          | C39343         | 1    |
| Al2     | 200 MHz Decade & Gate P.C.<br>Assembly  | C39327         | 1    |
| Al3     | Main Power P.C. Assembly                | B39351         | 1    |
| Al4     | "N" Computer P.C. Assembly              | B39375         | 1    |
| Al5     | Shifter P.C. Assembly                   | C39371         | 1    |
| Al6     | 200 MHz Amplifier P.C. Assembly         | B39323         | 1    |
| Al8,Al9 | 10 MHz Amplifier P.C. Assembly          | B39331         | 2    |
| A20     | Mixer Cable Assembly                    | B39784         | 1    |
| 46      | Extender P.C. Assembly                  | B39153         | 1    |
|         | Front Panel Assembly                    | D39188         |      |
| 1       | Decorative Panel                        | D39402-1       | 1    |
| 2       | Sub-panel                               | D39413         | 1    |
| 3       | Polarized Window                        | B39392         | 1    |
| 4       | Front Trim                              | C33762         | 2    |
| 5       | Trim Strip                              | B39394         | 1    |

# FINAL ASSEMBLY PARTS LIST (Cont'd)

| REF.                                    | DESCRIPTION                           | SD<br>PART NO. | QTY. |
|-----------------------------------------|---------------------------------------|----------------|------|
| S2                                      | Switch, Rotary                        | A39655         | 1    |
| S22                                     | Switch, Toggle w/Black Decorative Nut | S0397          | 1    |
| S3                                      | Switch, Pushbutton N.O.               | S0398          | 1    |
| S10,S12,<br>S13,S15,<br>S16,S17,<br>S18 | Switch, Slide, SPDT                   | 05034990       | 7    |
| R9-S4                                   | Switch & Potentiometer, SPST, 2 M     | R2702          | 1    |
| R1-S5,<br>R2-S6,<br>R3-S7               | Switch & Potentiometer, SPDT, 5 k     | R2077          | 3    |
| S9,S11,<br>S14                          | Switch, Slide, DPTT                   | S0399          | 3    |
| J1,J2,<br>J3                            | Connector, BNC                        | J0260          | 3    |
| 24                                      | Knob, Bar (Not Shown)                 | H1965          | 1    |
| 25                                      | Knob, Round (Not Shown)               | H1964          | 4    |
| 26                                      | Front Panel Cable Assembly            | D39779         | 1    |
|                                         | Rear Panel Assembly                   | D39187         |      |
| 1                                       | Rear Panel                            | D39314         | 1    |
| 2                                       | Cover Plate, Mixer                    | A39442         | 1    |
| 3                                       | Cover Plate, 36 Pin                   | A38621         | 1    |
| 4                                       | Cover Plate, 50 Pin                   | A39443-2       | 1    |
| 5                                       | Filter Assembly, AC Line              | A31331-4-1     | 1    |
| 6                                       | Plate, Fan Mounting                   | B39614         | 1    |
| B1                                      | Fan                                   | H1786          | 1    |
| S21                                     | Slide Switch, DPDT                    | S0384          | 1    |
| S8,S20,<br>S23                          | Slide Switch, SPDT                    | 05034990       | 3    |
| 10                                      | Fuse Holder                           | X0034          | 2    |
| 11                                      | Snap Button                           | H1667          | 3    |
| J5-J10,<br>J13                          | Connector, BNC                        | J0165          | 7    |
| F2                                      | Fuse, 1/4 A, Slo-Blo                  | F0067          | 1    |
| F1                                      | Fuse, 1 A, Slo-Blo                    | F0005          | 1    |
| 28                                      | Nameplate                             | A23456         |      |
|                                         | Bottom Cover Assembly                 | C39644         |      |
| 1                                       | Bottom Cover                          | D39643         | 1    |
| 2                                       | Bail & Foot Assembly                  | H1813          | 1    |

# FINAL ASSEMBLY PARTS LIST (Cont'd)

| REF.                | DESCRIPTION                   | SD<br>PART NO. | QTY. |
|---------------------|-------------------------------|----------------|------|
|                     | Test Assembly                 | D39641         |      |
| 1                   | Cage, Left Side               | C39155         | 1    |
| 2                   | Cage, Center Divider          | C39387         | 1    |
| 3                   | Cage, Front Plate             | C39154         | 1    |
| 4                   | Cage, Right Side              | C39386         | 1    |
| 5                   | Cage, Center Plate            | B39389         | 1    |
| 6                   | Cage, Runner                  | B39390         | 4    |
| 7                   | Side Support                  | B39388         | 1    |
| 8                   | Gusset, Left                  | C39436         | 1    |
| 9                   | Gusset, Right                 | C39437         | 1    |
| 12                  | P.C. Guide, Nylon             | A21340-1-1     | 18   |
| 13                  | P.C. Guide, Nylon, Modified   | A39567         | 2    |
| 14                  | P.C. Guide (Birtcher Clip)    | H1826          | 1    |
| 16                  | Caterpillar Strip             | H1829          | A/R  |
|                     | Power Supply Chassis Assembly | D39189         |      |
| 1                   | Chassis, Power Supply         | D39315         | 1    |
| 2                   | Transistor Bracket Assembly   | A39624         | 1    |
| T1                  | Transformer                   | C39573         | 1    |
| T2                  | Transformer                   | B19805         | 1    |
| Q1,Q2,<br>Q3        | Transistor, 2N5190            | Q0281          | 3    |
| Q4,Q5               | Transistor, 2N5193            | Q0300          | 2    |
| C2,C3               | Capacitor, 1100 $\mu$ F, 25 V | 03287050       | 2    |
| C1                  | Capacitor, 20 $\mu$ F, 450 V  | C1150          | 1    |
| C9                  | Capacitor, 500 $\mu$ F, 50 V  | 03286060       | 1    |
| CR1,CR2             | Diode, MRL120R                | CR0337         | 2    |
| 12                  | Capacitor, MTG, Wafer         | H0488          | 1    |
| 14                  | Grommet, Heyco, SB250-2       | H0883          | 1    |
| 15                  | Grommet, Heyco, SB375-4       | H1244          | 1    |
|                     | Mother Board P.C. Assembly    | C39114         |      |
| 9                   | Cage, Right Side              | C39386         | 1    |
| 10                  | Cage, Center Divider          | C39387         | 1    |
| 11                  | Side Support                  | B39388         | 1    |
| 12                  | Cage, Center Plate            | B39389         | 1    |
| 13                  | Cage, Runner                  | B39390         | 4    |
| 14                  | Cage, Front Plate             | C39154         | 1    |
| 15                  | Cage, Left Side               | C39155         | 1    |
| 16                  | Modification, P.C. Guide      | A39567         | 2    |
| C4,C5,<br>C6        | Capacitor, 4600 $\mu$ F, 12 V | C1112          | 3    |
| C10,C11,<br>C12,C13 | Capacitor, 4.7 $\mu$ F, 35 V  | C0406          | 4    |

# FINAL ASSEMBLY PARTS LIST (Cont'd)

| REF.                               | DESCRIPTION                        | SD<br>PART NO. | QTY. |
|------------------------------------|------------------------------------|----------------|------|
| C14                                | Capacitor, 27 pF, Chip             | C1250          | 1    |
| C15                                | Capacitor, .001 $\mu$ F, 1 kV      | C0235          | 1    |
| C16                                | Capacitor, .1 $\mu$ F, 600 V       | 03285090       | 1    |
| C17                                | Capacitor, .8-4.5 pF               | 03270220       | 1    |
| C18,C19                            | Capacitor, 22 pF, Chip             | C1177          | 2    |
| C20                                | Capacitor, 220 pF, Chip            | C1251          |      |
| CR3,CR4,<br>CR5                    | Diode, 1N4151                      | CR0150         | 3    |
| K1,K2                              | Relay, Reed, Form A, 1 kV          | K0132          | 2    |
| L3                                 | Inductor, .06 $\mu$ H              | L0158          |      |
| L4                                 | Coil Reed Switch                   | L0169          | 1    |
| R4                                 | Resistor, 22 $\Omega$ , 1/4 W, 5%  | R1436          | 1    |
| R5                                 | Resistor, 100 $\Omega$ , 1/4 W, 5% | R0966          | 1    |
| R6                                 | Not Used                           |                |      |
| R7                                 | Resistor, 910 k, 1/4 W, 5%         | R2312          | 1    |
| R8                                 | Resistor, 200 k, 1/4 W, 5%         | R0823          | 1    |
| R9                                 | Resistor, 20 k, 1/4 W, 5%          | R0964          | 1    |
| R10                                | Resistor, 180 k, 1/4 W, 5%         | R1042          | 1    |
| R13                                | Resistor, 47 $\Omega$ , 1/4 W, 5%  | R0743          |      |
| S1                                 | Switch, Pushbutton, 12 Sta.        | S0409          | 1    |
| S19                                | Switch, Reed, H.V.                 | A37288         | 1    |
| XA2-XA4,<br>XA6-XA16,<br>XA18,XA19 | Connector, 50 Pin P.C.             | J0606          | 16   |
| 35                                 | Grommet, Caterpillar               | 38023720       | A/R  |
|                                    | Mixer Cable Assembly               | B39784         |      |
| 1                                  | Mixer Assembly                     | C33351         | 1    |
| P18                                | Connector                          | J0605          | 1    |
|                                    | Transistor Bracket Assembly        | A39624         |      |
| 1                                  | Transistor Mtg. Bracket            | B39438         | 1    |
| 2                                  | Transistor Socket                  | X0187          | 5    |
| 3                                  | Transistor Socket Retainer         | H1966          | 5    |
| AlAl                               | Annunciator Assembly               | C39186         |      |
| 1                                  | Annunciator P.C. Board             | B39627         | 1    |
| 2                                  | Annunciator Block                  | C27873         | 1    |
| 3                                  | Spec, Annunciator Legend Film      | A39440         | 1    |
| 4                                  | Amp-Modu Post Strip, 86090-4       | E0322          | 9    |
| 5                                  | Lamp, Incandescent (CM7220)        | 10101          | 8    |
| 7                                  | Pressure Sensitive Tape            | H1768          | A/R  |



# BCD OUTPUT P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                      | SD<br>PART NO.   |
|------|--------------------------------------------------|------------------|
| AlA2 | BCD Output P.C. Assembly<br>BCD Output Schematic | B39379<br>D39376 |
| CR1  | Diode, 1N4151                                    | CR0150           |
| CR2  | Diode, 1N4151                                    | CR0150           |
| Q1   | Transistor, 2N3646                               | Q0218            |
| Q2   | Transistor, 2N3646                               | Q0218            |
| Q3   | Transistor, 2N3646                               | Q0218            |
| Q4   | Transistor, 2N3646                               | Q0218            |
| R1   | Resistor, 12 k, 1/4 W, 5%                        | R0759            |
| R2   | Resistor, 1 k, 1/4 W, 5%                         | R0765            |
| R3   | Resistor, 1 k, 1/4 W, 5%                         | R0765            |
| R4   | Resistor, 1 k, 1/4 W, 5%                         | R0765            |
| R5   | Resistor, 12 k, 1/4 W, 5%                        | R0759            |
| R6   | Resistor, 4.7 k, 1/4 W, 5%                       | R0892            |
| R7   | Resistor, 4.7 k, 1/4 W, 5%                       | R0892            |
| R8   | Resistor, 1 k, 1/4 W, 5%                         | R0765            |
| R9   | Resistor, 1 k, 1/4 W, 5%                         | R0765            |
| U1   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U2   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U3   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U4   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U5   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U6   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U7   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U8   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U9   | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |
| U10  | Resistor Network, 4 x 5 k, 1/10 W, 20%           | 27867            |

# READOUT P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                | SD<br>PART NO.   |
|------|--------------------------------------------|------------------|
| A1   | Readout P.C. Assembly<br>Readout Schematic | C39383<br>E39380 |
| C1   | Capacitor, .003 $\mu$ F, 500 V             | C0327            |
| C2   | Capacitor, .003 $\mu$ F, 500 V             | C0327            |
| C3   | Capacitor, .003 $\mu$ F, 500 V             | C0327            |
| C4   | Capacitor, .003 $\mu$ F, 500 V             | C0327            |
| C5   | Capacitor, 1 $\mu$ F, 35 V                 | C0524            |
| C6   | Capacitor, .003 $\mu$ F, 500 V             | C0327            |
| C7   | Capacitor, .003 $\mu$ F, 500 V             | C0327            |
| C8   | Capacitor, .003 $\mu$ F, 500 V             | C0327            |
| C9   | Not Used                                   |                  |
| C10  | Capacitor, 1 $\mu$ F, 35 V                 | C0524            |
| C    |                                            |                  |
| C11  | Capacitor, 1 $\mu$ F, 35 V                 | C0524            |
| J16  | Socket, 14 Pin                             | X0186            |
| J17  | Socket, 14 Pin                             | X0186            |
| Q1   | Transistor, 2N3646                         | Q0218            |
| Q2   | Transistor, 2N3646                         | Q0218            |
| Q3   | Transistor, 2N3646                         | Q0218            |
| R1   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R2   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R3   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R4   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R5   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R6   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R7   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R8   | Resistor, 39 k, 1/2 W, 5%                  | R0282            |
| R9   | Not Used                                   |                  |
| R10  | Resistor, 1 k, 1/4 W, 5%                   | R0765            |
| R11  | Resistor, 1 k, 1/4 W, 5%                   | R0765            |
| R12  | Resistor, 1 k, 1/4 W, 5%                   | R0765            |
| U1   | Integrated Circuit, SN74141N               | 25730            |
| U2   | Integrated Circuit, SN74141N               | 25730            |
| U3   | Integrated Circuit, SN74141N               | 25730            |
| U4   | Integrated Circuit, SN74141N               | 25730            |
| U5   | Integrated Circuit, SN74141N               | 25730            |
| U6   | Integrated Circuit, SN74141N               | 25730            |
| U7   | Integrated Circuit, SN74141N               | 25730            |
| U8   | Integrated Circuit, SN74141N               | 25730            |
| U9   | Not Used                                   |                  |
| U10  | Integrated Circuit, SN74141N               | 25730            |

# READOUT P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                      | SD<br>PART NO. |
|------|----------------------------------|----------------|
| U11  | Integrated Circuit, SN7475N      | 19710          |
| U12  | Integrated Circuit, SN7475N      | 19710          |
| U13  | Integrated Circuit, SN7475N      | 19710          |
| U14  | Integrated Circuit, SN7475N      | 19710          |
| U15  | Integrated Circuit, SN7475N      | 19710          |
| U16  | Integrated Circuit, SN7475N      | 19710          |
| U17  | Integrated Circuit, SN7475N      | 19710          |
| U18  | Integrated Circuit, SN7475N      | 19710          |
| U19  | Not Used                         |                |
| U20  | Integrated Circuit, SN74196N     | 25784          |
| U21  | Integrated Circuit, SN7490N      | 25732          |
| U22  | Integrated Circuit, SN7490N      | 25732          |
| U23  | Integrated Circuit, SN7490N      | 25732          |
| U24  | Integrated Circuit, SN7490N      | 25732          |
| U25  | Integrated Circuit, SN7490N      | 25732          |
| U26  | Integrated Circuit, SN7490N      | 25732          |
| U27  | Not Used                         |                |
| U28  | Integrated Circuit, SN74145N     | 25754          |
| U29  | Integrated Circuit, SN15846N     | 19716          |
| U30  | Integrated Circuit, SN7474N      | 25241          |
| V1   | Readout Tube, NL-5859S           | V0131          |
| V2   | Readout Tube, NL-5859S           | V0131          |
| V3   | Readout Tube, NL-5859S           | V0131          |
| V4   | Readout Tube, NL-5859S           | V0131          |
| V5   | Readout Tube, NL-5859S           | V0131          |
| V6   | Readout Tube, NL-5859S           | V0131          |
| V7   | Readout Tube, NL-5859S           | V0131          |
| V8   | Readout Tube, NL-5859S           | V0131          |
| XA1  | Socket, Annunciator, 10 Pin      | J0608          |
| XA2  | Socket, BCD Output P.C. Assembly | J0621          |
| XV1  | Socket, Readout Tube, RTS-44     | X0179          |
| XV2  | Socket, Readout Tube, RTS-44     | X0179          |
| XV3  | Socket, Readout Tube, RTS-44     | X0179          |
| XV4  | Socket, Readout Tube, RTS-44     | X0179          |
| XV5  | Socket, Readout Tube, RTS-44     | X0179          |
| XV6  | Socket, Readout Tube, RTS-44     | X0179          |
| XV7  | Socket, Readout Tube, RTS-44     | X0179          |
| XV8  | Socket, Readout Tube, RTS-44     | X0179          |
| XU1  | Socket, IC, 8 Pin                | X0185          |
| XU2  | Socket, IC, 8 Pin                | X0185          |
| XU3  | Socket, IC, 8 Pin                | X0185          |

# READOUT P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION              | SD<br>PART NO. |
|------|--------------------------|----------------|
| XU4  | Socket, IC, 8 Pin        | X0185          |
| XU5  | Socket, IC, 8 Pin        | X0185          |
| XU6  | Socket, IC, 8 Pin        | X0185          |
| XU7  | Socket, IC, 8 Pin        | X0185          |
| XU8  | Socket, IC, 8 Pin        | X0185          |
| XU9  | Not Used                 |                |
| XU10 | Socket, IC, 8 Pin        | X0185          |
| XU28 | Socket, IC, 8 Pin        | X0185          |
| AlA1 | Annunciator Assembly     | 39186          |
| AlA2 | BCD Output P.C. Assembly | 39379          |

### 3 MHz OSCILLATOR POWER P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                          | SD<br>PART NO. |
|------|--------------------------------------|----------------|
| A2   | 3 MHz Oscillator Power P.C. Assembly | B39367         |
|      | 3 MHz Oscillator Power Schematic     | B39364         |
| C1   | Capacitor, 100 pF, 500 V, 5%         | C0536          |
| C2   | Capacitor, .05 $\mu$ F, 12 V         | C0672          |
| CR1  | Diode, 1N4005, 600 V, 1 Amp          | CR0284         |
| CR2  | Diode, 1N4005, 600 V, 1 Amp          | CR0284         |
| CR3  | Diode, 1N4005, 600 V, 1 Amp          | CR0284         |
| CR4  | Diode, 1N4005, 600 V, 1 Amp          | CR0284         |
| Q1   | Transistor, 2N5190                   | Q0281          |
| Q2   | Transistor, 2N3646                   | Q0218          |
| R1   | Resistor, 5.6 k, 1/4 W, 5%           | R0821          |
| R2   | Resistor, 27 k, 1/4 W, 5%            | R0824          |
| R3   | Resistor, 20 k, 1/4 W, 5%            | R0964          |
| R4   | Resistor, 6.8 k, 1/4 W, 5%           | R0696          |
| R5   | Resistor, 5.6 k, 1/4 W, 5%           | R0821          |
| R6   | Resistor, 1 k, 1/4 W, 5%             | R0765          |
| R7   | Resistor, 1 k, 1/4 W, 5%             | R0765          |
| R8   | Resistor, 5.6 k, 1/4 W, 5%           | R0821          |
| U1   | Integrated Circuit, U723C            | 25756          |
| U2   | Integrated Circuit, 7473N            | 19709          |



# 10 MHz OSCILLATOR P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                                    | SD<br>PART NO.   |
|------|----------------------------------------------------------------|------------------|
| A3   | 10 MHz Oscillator P.C. Assembly<br>10 MHz Oscillator Schematic | B39359<br>C39356 |
| C1   | Capacitor, .1 $\mu$ F, 200 V                                   | C0987            |
| C2   | Capacitor, .8-18 pF, Piston                                    | C0555            |
| C3   | Capacitor, 100 pF, 500 V                                       | C0536            |
| C4   | Capacitor, 220 pF, 500 V                                       | C0538            |
| C5   | Capacitor, 15 pF, 500 V                                        | C0528            |
| C6   | Capacitor, .001 $\mu$ F, 1 kV                                  | C0235            |
| C7   | Capacitor, .001 $\mu$ F, 1 kV                                  | C0235            |
| C8   | Capacitor, .1 $\mu$ F, 50 V                                    | C0881            |
| C9   | Capacitor, .05 $\mu$ F, 100 V                                  | C0708            |
| C10  | Capacitor, 33 pF, 500 V                                        | C0531            |
| C11  | Capacitor, 10 pF, 500 V                                        | C0527            |
| C12  | Capacitor, .1 $\mu$ F, 10 V                                    | C0661            |
| C13  | Capacitor, .001 $\mu$ F, 1 kV                                  | C0235            |
| C14  | Capacitor, 47 pF, 500 V                                        | C0533            |
| C15  | Capacitor, .001 $\mu$ F, 1 kV                                  | C0235            |
| C16  | Capacitor, .001 $\mu$ F, 1 kV                                  | C0235            |
| C17  | Capacitor, .01 $\mu$ F, 100 V                                  | C0556            |
| C18  | Capacitor, 680 pF, 300 V                                       | C0638            |
| C19  | Capacitor, .1 $\mu$ F, 50 V                                    | C0881            |
| C20  | Capacitor, .01 $\mu$ F, 100 V                                  | C0556            |
| C21  | Capacitor, .02 $\mu$ F, 150 V                                  | C0322            |
| C22  | Capacitor, .05 $\mu$ F, 12 V                                   | C0672            |
| C23  | Capacitor, .05 $\mu$ F, 12 V                                   | C0672            |
| C24  | Capacitor, .01 $\mu$ F, 100 V                                  | C0556            |
| C25  | Capacitor, 150 pF, 500 V                                       | C0537            |
| CR1  | Diode, 1N4151                                                  | CR0150           |
| CR2  | Diode, 1N4151                                                  | CR0150           |
| CR3  | Diode, MV2107                                                  | CR0375           |
| CR4  | Diode, 1N4151                                                  | CR0150           |
| CR5  | Diode, 1N4151                                                  | CR0150           |
| CR6  | Diode, 1N4151                                                  | CR0150           |
| CR7  | Diode, 1N4151                                                  | CR0150           |
| CR8  | Diode, HPA 5082-2800                                           | CR0363           |
| CR9  | Diode, HPA 5082-2800                                           | CR0363           |
| VR1  | Diode, Zener                                                   | CR19330          |
| VR2  | Diode, Zener                                                   | CR19330          |
| Q1   | Transistor, 2N4275                                             | 26013140         |
| Q2   | Transistor, 2N4275                                             | 26013140         |
| Q3   | Transistor, 2N4275                                             | 26013140         |

# 10 MHz OSCILLATOR P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                            | SD<br>PART NO. |
|------|----------------------------------------|----------------|
| R1   | Resistor, 680 $\Omega$ , 1/4 W, 5%     | R1234          |
| R2   | Resistor, 2.7 k, 1/4 W, 5%             | R0937          |
| R3   | Resistor, 330 k, 1/4 W, 5%             | R0662          |
| R4   | Resistor, 1.8 k, 1/4 W, 5%             | R0959          |
| R5   | Resistor, 100 k, 1/4 W, 5%             | R0741          |
| R6   | Resistor, 47 k, 1/4 W, 5%              | R0771          |
| R7   | Not Used                               |                |
| R8   | Resistor, 100 k, 1/4 W, 5%             | R0741          |
| R9   | Resistor, 4.7 k, 1/4 W, 5%             | R0892          |
| R10  | Resistor, 10 k, 1/4 W, 5%              | R0766          |
| R11  | Resistor, 1 k, 1/4 W, 5%               | R0765          |
| R12  | Resistor, 3.3 k, 1/4 W, 5%             | R0742          |
| R13  | Resistor, 1 k, 1/4 W, 5%               | R0765          |
| R14  | Resistor, 2.2 M, 1/4 W, 5%             | R1014          |
| R15  | Resistor, 2.7 k, 1/4 W, 5%             | R0937          |
| R16  | Resistor, 2.2 M, 1/4 W, 5%             | R1014          |
| R17  | Not Used                               |                |
| R18  | Resistor, 150 k, 1/4 W, 5%             | R0961          |
| R19  | Resistor, 150 k, 1/4 W, 5%             | R0961          |
| R20  | Resistor, 20 k, 1/4 W, 5%              | R0964          |
| R21  | Resistor, 1.8 k, 1/4 W, 5%             | R0959          |
| R22  | Resistor, 10 k, 1/4 W, 5%              | R0766          |
| R23  | Resistor, 200 $\Omega$ , Potentiometer | 01110240       |
| R24  | Resistor, 1.8 k, 1/4 W, 5%             | R0959          |
| R25  | Resistor, 1 k, 1/4 W, 5%               | R0765          |
| R26  | Resistor, 1 M, 1/4 W, 5%               | R0962          |
| R27  | Resistor, 2.7 k, 1/4 W, 5%             | R0937          |
| R28  | Resistor, 330 $\Omega$ , 1/4 W, 5%     | R0662          |
| R29  | Resistor, 1.8 k, 1/4 W, 5%             | R0959          |
| R30  | Resistor, 680 $\Omega$ , 1/4 W, 5%     | R1234          |
| T1   | Transformer                            | A39682         |
| TP1  | Test Point, Brown                      | E0235          |
| U1   | Integrated Circuit, SN7400N            | 19705          |
| U2   | Integrated Circuit, SN7400N            | 19705          |
| U3   | Integrated Circuit, MC3000P            | 25766          |
| U4   | Integrated Circuit, LM301A             | 25745          |
| U5   | Integrated Circuit, MC3060             | 25769          |
| Y1   | Crystal, 10 MHz                        | A39483         |

# 100 MHz MULTIPLIER P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                                      | SD<br>PART NO.   |
|------|------------------------------------------------------------------|------------------|
| A4   | 100 MHz Multiplier P.C. Assembly<br>100 MHz Multiplier Schematic | B39363<br>C39360 |
| C1   | Capacitor, .1 $\mu$ F, 50 V                                      | C0881            |
| C2   | Capacitor, 180 pF, 500 V                                         | C0707            |
| C3   | Capacitor, 390 pF, 500 V                                         | C0541            |
| C4   | Capacitor, .01 $\mu$ F, 50 V                                     | C0562            |
| C5   | Capacitor, .1 $\mu$ F, 50 V                                      | C0881            |
| C6   | Capacitor, 47 pF, 500 V                                          | C0533            |
| C7   | Capacitor, .1 $\mu$ F, 50 V                                      | C0881            |
| C8   | Capacitor, .01 $\mu$ F, 50 V                                     | C0562            |
| C9   | Capacitor, .01 $\mu$ F, 50 V                                     | C0562            |
| C10  | Capacitor, 15-60 pF                                              | C1132            |
| C11  | Capacitor, 2 pF, 500 V                                           | C0261            |
| C12  | Capacitor, 15-60 pF                                              | C1132            |
| C13  | Capacitor, 180 pF, 500 V                                         | C0707            |
| C14  | Capacitor, 470 pF, 300 V                                         | C0542            |
| C15  | Capacitor, 5.5-18 pF                                             | C0712            |
| C16  | Capacitor, 5.5-18 pF                                             | C0712            |
| C17  | Capacitor, 82 pF, 500 V                                          | C0535            |
| C18  | Capacitor, 2 pF, 500 V                                           | C0261            |
| C19  | Capacitor, .1 $\mu$ F, 50 V                                      | C0881            |
| L1   | Inductor, .82 $\mu$ H                                            | L0059            |
| L2   | Inductor, SD B39744-1                                            | B39744-1         |
| L3   | Inductor, SD B39744-1                                            | B39744-1         |
| L4   | Inductor, SD B39744-2                                            | B39744-2         |
| L5   | Inductor, SD B39744-2                                            | B39744-2         |
| Q1   | Transistor, 2N3640                                               | Q0178            |
| Q2   | Transistor, 2N3646                                               | Q0218            |
| Q3   | Transistor, 2N3646                                               | Q0218            |
| Q4   | Transistor, 2N3646                                               | Q0218            |
| R1   | Resistor, 3.3 k, 1/4 W, 5%                                       | R0742            |
| R2   | Resistor, 560 $\Omega$ , 1/4 W, 5%                               | R0819            |
| R3   | Resistor, 6.8 k, 1/4 W, 5%                                       | R0696            |
| R4   | Resistor, 3.3 k, 1/4 W, 5%                                       | C0742            |
| R5   | Resistor, 560 $\Omega$ , 1/4 W, 5%                               | R0819            |
| R6   | Resistor, 470 $\Omega$ , 1/4 W, 5%                               | R1044            |
| R7   | Resistor, 1 k, 1/4 W, 5%                                         | R0765            |
| R8   | Resistor, 120 $\Omega$ , 1/4 W, 5%                               | R1461            |
| R9   | Resistor, 470 $\Omega$ , 1/4 W, 5%                               | R1044            |
| R10  | Resistor, 1 k, 1/4 W, 5%                                         | R0765            |

# 100 MHz MULTIPLIER P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R11  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R12  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |

# ATTENUATOR SELECT P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                                    | SD<br>PART NO.   |
|------|----------------------------------------------------------------|------------------|
| A6   | Attenuator Select P.C. Assembly<br>Attenuator Select Schematic | B39355<br>B39352 |
| R1   | Resistor, 5.6 k, 1/4 W, 5%                                     | R0821            |
| U1   | Resistor Network, 4 x 5 k, 1/10 W, 20%                         | 27867            |
| U2   | Resistor Network, 4 x 5 k, 1/10 W, 20%                         | 27867            |
| U3   | Resistor Network, 4 x 5 k, 1/10 W, 20%                         | 27867            |
| U4   | Resistor Network, 4 x 5 k, 1/10 W, 20%                         | 27867            |
| U5   | Resistor Network, 4 x 5 k, 1/10 W, 20%                         | 27867            |
| U6   | Resistor Network, 4 x 5 k, 1/10 W, 20%                         | 27867            |



# FUNCTION SELECT P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                                | SD<br>PART NO.   |
|------|------------------------------------------------------------|------------------|
| A7   | Function Select P.C. Assembly<br>Function Select Schematic | B39803<br>B39800 |
| C1   | Capacitor, .05 $\mu$ F, 12 V                               | C0672            |
| C2   | Capacitor, .05 $\mu$ F, 12 V                               | C0672            |
| R1   | Resistor, 5.6 k, 1/4 W, 5%                                 | R0821            |
| U1   | Integrated Circuit, MC836P                                 | 25704            |
| U2   | Integrated Circuit, SN15862N                               | 19719            |
| U3   | Resistor Network, 4 x 5 k, 1/10 W                          | 27867            |
| U4   | Resistor Network, 4 x 5 k, 1/10 W                          | 27867            |
| U5   | Resistor Network, 4 x 5 k, 1/10 W                          | 27867            |
| U6   | Resistor Network, 4 x 5 k, 1/10 W                          | 27867            |
| U7   | Resistor Network, 4 x 5 k, 1/10 W                          | 27867            |
| U8   | Resistor Network, 4 x 5 k, 1/10 W                          | 27867            |

# LEGEND LOGIC P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                          | SD<br>PART NO.   |
|------|------------------------------------------------------|------------------|
| A8   | Legend Logic P.C. Assembly<br>Legend Logic Schematic | C39335<br>C39332 |
| C1   | Capacitor, .1 $\mu$ F, 10 V                          | C0661            |
| C2   | Capacitor, .1 $\mu$ F, 10 V                          | C0661            |
| C3   | Capacitor, .1 $\mu$ F, 10 V                          | C0661            |
| CR1  | Diode, 1N4151                                        | CR0150           |
| U1   | Integrated Circuit, 15846N                           | 19716            |
| U2   | Integrated Circuit, 15846N                           | 19716            |
| U3   | Integrated Circuit, 15846N                           | 19716            |
| U4   | Integrated Circuit, 15846N                           | 19716            |
| U5   | Integrated Circuit, 15846N                           | 19716            |
| U6   | Integrated Circuit, 15846N                           | 19716            |
| U7   | Integrated Circuit, 15862N                           | 19719            |
| U8   | Integrated Circuit, 15862N                           | 19719            |
| U9   | Integrated Circuit, 15830N                           | 19712            |
| U10  | Integrated Circuit, MC836                            | 25704            |
| U11  | Integrated Circuit, MC836                            | 25704            |
| U12  | Integrated Circuit, MC836                            | 25704            |

# DECIMAL LOGIC P.C. ASSEMBLY

| REF. | DESCRIPTION                                            | SD<br>PART NO.   |
|------|--------------------------------------------------------|------------------|
| A9   | Decimal Logic P.C. Assembly<br>Decimal Logic Schematic | B39339<br>C39336 |
| C1   | Capacitor, .1 $\mu$ F, 10 V                            | C0661            |
| C2   | Capacitor, .1 $\mu$ F, 10 V                            | C0661            |
| C3   | Capacitor, .1 $\mu$ F, 10 V                            | C0661            |
| U1   | Integrated Circuit, MC836                              | 25704            |
| U2   | Integrated Circuit, 15846N                             | 19716            |
| U3   | Integrated Circuit, 15846N                             | 19716            |
| U4   | Integrated Circuit, 15830N                             | 19712            |
| U5   | Integrated Circuit, 15846N                             | 19716            |
| U6   | Integrated Circuit, 15846N                             | 19716            |
| U7   | Integrated Circuit, 15846N                             | 19716            |
| U8   | Integrated Circuit, 15846N                             | 19716            |
| U9   | Integrated Circuit, 15846N                             | 19716            |
| U10  | Integrated Circuit, 15846N                             | 19716            |
| U11  | Integrated Circuit, 15830N                             | 19712            |
| U12  | Integrated Circuit, 15846N                             | 19716            |
| U13  | Integrated Circuit, 15846N                             | 19716            |

# TIME BASE P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                    | SD<br>PART NO.   |
|------|------------------------------------------------|------------------|
| A10  | Time Base P.C. Assembly<br>Time Base Schematic | C39347<br>C39344 |
| C1   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| C2   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| C3   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| C4   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| C5   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| C6   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| C7   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| C8   | Capacitor, .05 $\mu$ F, 12 V                   | C0672            |
| R1   | Resistor, 4.7 k, 1/4 W, 5%                     | R0892            |
| R2   | Not Used                                       |                  |
| R3   | Resistor, 470 $\Omega$ , 1/4 W, 5%             | R1044            |
| R4   | Resistor, 470 $\Omega$ , 1/4 W, 5%             | R1044            |
| R5   | Resistor, 330 $\Omega$ , 1/4 W, 5%             | R0662            |
| R6   | Resistor, 470 $\Omega$ , 1/4 W, 5%             | R1044            |
| U1   | Integrated Circuit, SN74196N                   | 25784            |
| U2   | Integrated Circuit, SN7090N                    | 25732            |
| U3   | Integrated Circuit, SN7090N                    | 25732            |
| U4   | Integrated Circuit, SN7090N                    | 25732            |
| U5   | Integrated Circuit, SN7090N                    | 25732            |
| U6   | Integrated Circuit, SN7090N                    | 25732            |
| U7   | Integrated Circuit, SN7090N                    | 25732            |
| U8   | Integrated Circuit, SN7090N                    | 25732            |
| U9   | Integrated Circuit, SN7090N                    | 25732            |
| U10  | Integrated Circuit, SN7090N                    | 25732            |
| U11  | Integrated Circuit, SN7090N                    | 25732            |
| U12  | Integrated Circuit, SN7090N                    | 25732            |
| U13  | Integrated Circuit, SN7090N                    | 25732            |
| U14  | Integrated Circuit, SN7410N                    | 19706            |
| U15  | Integrated Circuit, SN7454N                    | 25772            |
| U16  | Integrated Circuit, SN7454N                    | 25772            |
| U17  | Integrated Circuit, SN7400N                    | 19705            |
| U18  | Integrated Circuit, SN7454N                    | 25772            |
| U19  | Integrated Circuit, SN15846N                   | 19716            |
| U20  | Integrated Circuit, SN7400N                    | 19705            |
| U21  | Integrated Circuit, SN15846N                   | 19716            |
| U22  | Integrated Circuit, SN15846N                   | 19716            |

# FUNCTION CONTROL P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                                  | SD<br>PART NO.   |
|------|--------------------------------------------------------------|------------------|
| All  | Function Control P.C. Assembly<br>Function Control Schematic | C39343<br>D39340 |
| C1   | Capacitor, .001 $\mu$ F, 1000 V                              | C0235            |
| C2   | Capacitor, .22 $\mu$ F, 35 V                                 | C0354            |
| C3   | Capacitor, 2.2 $\mu$ F, 20 V                                 | C1009            |
| C4   | Capacitor, 4.7 $\mu$ F, 35 V                                 | C0406            |
| C5   | Capacitor, 680 pF, 500 V                                     | C0638            |
| C6   | Capacitor, .033 $\mu$ F, 35 V                                | C1288            |
| C7   | Not Used                                                     |                  |
| C8   | Capacitor, .22 $\mu$ F, 35 V                                 | C0354            |
| C9   | Capacitor, 4.7 $\mu$ F, 35 V                                 | C0406            |
| C10  | Capacitor, .01 $\mu$ F, 100 V                                | C0556            |
| C11  | Capacitor, 56 $\mu$ F, 5 V                                   | C1090            |
| C12  | Capacitor, 56 $\mu$ F, 5 V                                   | C1090            |
| C13  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672            |
| C14  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672            |
| C15  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672            |
| C16  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672            |
| CR1  | Diode, 1N4151                                                | CR0150           |
| CR2  | Diode, 1N4151                                                | CR0150           |
| CR3  | Diode, 1N4151                                                | CR0150           |
| CR4  | Diode, 1N4151                                                | CR0150           |
| CR5  | Diode, 1N4151                                                | CR0150           |
| K1   | Relay, Reed, Form A, 250 V                                   | K0133            |
| Q1   | Transistor, 2N3646                                           | Q0218            |
| Q2   | Transistor, 2N4871                                           | Q0266            |
| Q3   | Transistor, 2N3646                                           | Q0218            |
| Q4   | Transistor, 2N3646                                           | Q0218            |
| Q5   | Transistor, 2N3646                                           | Q0218            |
| Q6   | Transistor, 2N3646                                           | Q0218            |
| R1   | Resistor, 4.7 k, 1/4 W, 5%                                   | R0892            |
| R2   | Resistor, 4.7 k, 1/4 W, 5%                                   | R0892            |
| R3   | Resistor, 4.8 k, 1/4 W, 5%                                   | R0696            |
| R4   | Resistor, 1 k, 1/4 W, 5%                                     | R0765            |
| R5   | Resistor, 4.7 k, 1/4 W, 5%                                   | R0892            |
| R6   | Resistor, 10 k, 1/4 W, 5%                                    | R0766            |
| R7   | Resistor, 470 $\Omega$ , 1/4 W, 5%                           | R1044            |
| R8   | Resistor, 470 $\Omega$ , 1/4 W, 5%                           | R1044            |
| R9   | Resistor, 4.7 k, 1/4 W, 5%                                   | R0892            |
| R10  | Resistor, 470 $\Omega$ , 1/4 W, 5%                           | R1044            |



# FUNCTION CONTROL P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R11  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R12  | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R13  | Resistor, 12 k, 1/4 W, 5%          | R0759          |
| R14  | Resistor, 3.3 k, 1/4 W, 5%         | R0742          |
| R15  | Resistor, 1 k, 1/4 W, 5%           | R0766          |
| R16  | Resistor, 1.5 k, 1/4 W, 5%         | R0783          |
| R17  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R18  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R19  | Resistor, 2.7 k, 1/4 W, 5%         | R0937          |
| R20  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R21  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R22  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R23  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R24  | Not Used                           |                |
| R25  | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R26  | Resistor, 560 $\Omega$ , 1/4 W, 5% | R0819          |
| R27  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R28  | Resistor, 22 $\Omega$ , 1/4 W, 5%  | R0783          |
| U1   | Integrated Circuit, SN15862N       | 19719          |
| U2   | Integrated Circuit, SN15846N       | 19716          |
| U3   | Integrated Circuit, SN15830N       | 19712          |
| U4   | Integrated Circuit, SN15846N       | 19716          |
| U5   | Integrated Circuit, SN15846N       | 19716          |
| U6   | Integrated Circuit, SN15862N       | 19719          |
| U7   | Integrated Circuit, MC1810P        | 25735          |
| U8   | Integrated Circuit, SN15846N       | 19716          |
| U9   | Integrated Circuit, SN15846N       | 19716          |
| U10  | Integrated Circuit, SN15846N       | 19716          |
| U11  | Integrated Circuit, SN15862N       | 19719          |
| U12  | Integrated Circuit, SN7400N        | 19705          |
| U13  | Integrated Circuit, SN7400N        | 19705          |
| U14  | Integrated Circuit, SN7400N        | 19705          |
| U15  | Integrated Circuit, SN7400N        | 19705          |

## 200 MHz DECADE &amp; GATE P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                                            | SD<br>PART NO.   |
|------|------------------------------------------------------------------------|------------------|
| A12  | 200 MHz Decade & Gate P.C. Assembly<br>200 MHz Decade & Gate Schematic | C39327<br>D39324 |
| C1   | Capacitor, 47 pF, 500 V                                                | C0533            |
| C2   | Capacitor, 47 pF, 500 V                                                | C0533            |
| C3   | Capacitor, 47 pF, 500 V                                                | C0533            |
| C4   | Capacitor, 47 pF, 500 V                                                | C0533            |
| C5   | Capacitor, 47 pF, 500 V                                                | C0533            |
| C6   | Capacitor, 47 pF, 500 V                                                | C0533            |
| C7   | Capacitor, .001 $\mu$ F, 75 V                                          | C1155            |
| C8   | Capacitor, .001 $\mu$ F, 75 V                                          | C1155            |
| C9   | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C10  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C11  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C12  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C13  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C14  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C15  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C16  | Capacitor, 39 $\mu$ F, 10 V                                            | C0902            |
| C17  | Capacitor, .001 $\mu$ F, 75 V                                          | C1155            |
| C18  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C19  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C20  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C21  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C22  | Capacitor, 39 $\mu$ F, 10 V                                            | C0902            |
| C23  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C24  | Not Used                                                               |                  |
| C25  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C26  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C27  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C28  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C29  | Capacitor, .05 $\mu$ F, 12 V                                           | C0672            |
| C30  | Capacitor, 39 $\mu$ F, 10 V                                            | C0902            |
| CR1  | Not Used                                                               |                  |
| CR2  | Diode, 1N4151                                                          | CR0150           |
| CR3  | Diode, 1N4830                                                          | CR0361           |
| CR4  | Diode, 1N4151                                                          | CR0150           |
| CR5  | Diode, 1N4151                                                          | CR0150           |
| CR6  | Diode, 1N4151                                                          | CR0150           |
| CR7  | Diode, 1N4151                                                          | CR0150           |
| CR8  | Diode, 1N4151                                                          | CR0150           |
| CR9  | Diode, 1N4151                                                          | CR0150           |

# 200 MHz DECADE & GATE P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| L1   | Inductor, RF R45-4                 | L0143          |
| L2   | Inductor, RF R45-4                 | L0143          |
| L3   | Inductor, RF R45-4                 | L0143          |
| Q1   | Transistor, 2N3640                 | Q0178          |
| Q2   | Transistor, 2N3640                 | Q0178          |
| Q3   | Transistor, 2N3640                 | Q0178          |
| Q4   | Transistor, 2N3646                 | Q0218          |
| Q5   | Transistor, 2N3646                 | Q0218          |
| R1   | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R2   | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R3   | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R4   | Resistor, 100 $\Omega$ , 1/8 W, 5% | R1441          |
| R5   | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R6   | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R7   | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R8   | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R9   | Resistor, 47 k, 1/4 W, 5%          | R0777          |
| R10  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R11  | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R12  | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R13  | Resistor, 4.7 k, 1/8 W, 5%         | R1733          |
| R14  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R15  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R16  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R17  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
| R18  | Resistor, 200 $\Omega$ , 1/4 W, 5% | R0736          |
| R19  | Resistor, 56 $\Omega$ , 1/4 W, 5%  | R1554          |
| R20  | Resistor, 47 k, 1/4 W, 5%          | R0777          |
| R21  | Resistor, 47 k, 1/4 W, 5%          | R0777          |
| R22  | Resistor, 47 k, 1/4 W, 5%          | R0777          |
| R23  | Resistor, 1 k, 1/8 W, 5%           | R1453          |
| R24  | Resistor, 3.3 k, 1/8 W, 5%         | R1456          |
| R25  | Resistor, 470 $\Omega$ , 1/8 W, 5% | R1451          |
| R26  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R27  | Resistor, 2.2 k, 1/4 W, 5%         | R0749          |
| R28  | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R29  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R30  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R31  | Resistor, 2.2 k, 1/4 W, 5%         | R0749          |
| R32  | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R33  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R34  | Resistor, 1 k, 1/8 W, 5%           | R1453          |
| R35  | Resistor, 1 k, 1/8 W, 5%           | R1453          |

# 200 MHz DECADE & GATE P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R36  | Resistor, 47 k, 1/4 W, 5%          | R0777          |
| R37  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R38  | Resistor, 510 $\Omega$ , 1/4 W, 5% | R0984          |
| R39  | Resistor, 510 $\Omega$ , 1/4 W, 5% | R0984          |
| R40  | Resistor, 510 $\Omega$ , 1/4 W, 5% | R0984          |
| R41  | Resistor, 510 $\Omega$ , 1/4 W, 5% | R0984          |
| R42  | Resistor, 510 $\Omega$ , 1/4 W, 5% | R0984          |
| R43  | Resistor, 510 $\Omega$ , 1/4 W, 5% | R0984          |
| R44  | Resistor, 270 $\Omega$ , 1/4 W, 5% | R0694          |
| U1   | Integrated Circuit, MC1662L        | 25778          |
| U2   | Integrated Circuit, MC1010P        | 25775          |
| U3   | Integrated Circuit, MC1010P        | 25775          |
| U4   | Integrated Circuit, MC1010P        | 25775          |
| U5   | Integrated Circuit, MC1023P        | 25718          |
| U6   | Integrated Circuit, SN7400N        | 19705          |
| U7   | Integrated Circuit, SN7400N        | 19705          |
| U8   | Integrated Circuit, MC1660L        | 25777          |
| U9   | Integrated Circuit, MC1011P        | 25776          |
| U10  | Integrated Circuit, MC1660L        | 25777          |
| U11  | Integrated Circuit, MC1010P        | 25775          |
| U12  | Integrated Circuit, MC1023P        | 25718          |
| U13  | Integrated Circuit, MC1670L        | 25765          |
| U14  | Integrated Circuit, MC1034P        | 25773          |
| U15  | Integrated Circuit, MC1034P        | 25773          |
| U16  | Integrated Circuit, MC1039P        | 25774          |
| U17  | Integrated Circuit, MC1039P        | 25774          |
| U18  | Integrated Circuit, MC1027P        | 25719          |
| U19  | Integrated Circuit, MC1027P        | 25719          |
| U20  | Integrated Circuit, MC1027P        | 25719          |
| VR1  | Diode, Breakdown, A39543           | A39543         |
| VR2  | Diode, Breakdown, A39543           | A39543         |
| VR3  | Diode, Breakdown, A39543           | A39543         |
| VR4  | Diode, Breakdown, A39543           | A39543         |
| VR5  | Diode, Breakdown, A39543           | A39543         |
| VR6  | Diode, Breakdown, A39543           | A39543         |
| VR7  | Diode, Breakdown, A39543           | A39543         |
| VR8  | Diode, Breakdown, A39543           | A39543         |
| VR9  | Diode, Breakdown, A39543           | A39543         |
| VR10 | Diode, Breakdown, A39543           | A39543         |

# MAIN POWER P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                       | SD<br>PART NO.   |
|------|---------------------------------------------------|------------------|
| A13  | Main Power P.C. Assembly<br>Main Power Schematic  | B39351<br>C39348 |
| C1   | Capacitor, 470 pF, 300 V                          | C0542            |
| C2   | Capacitor, 470 pF, 300 V                          | C0542            |
| C3   | Capacitor, 470 pF, 300 V                          | C0542            |
| C4   | Capacitor, 470 pF, 300 V                          | C0542            |
| C5   | Capacitor, .001 $\mu$ F, 1000 V                   | C0235            |
| C6   | Capacitor, 100 $\mu$ F, 25 V, Tant                | C0832            |
| CR1  | Diode, 1N4005                                     | CR0284           |
| CR2  | Diode, 1N4005                                     | CR0284           |
| CR3  | Diode, 1N4005                                     | CR0284           |
| CR4  | Diode, 1N4005                                     | CR0284           |
| CR5  | Diode, 1N4005                                     | CR0284           |
| CR6  | Diode, 1N4005                                     | CR0284           |
| CR7  | Diode, 1N4005                                     | CR0284           |
| CR8  | Diode, 1N4005                                     | CR0284           |
| CR9  | Diode, 1N4719                                     | CR0251           |
| CR10 | Diode, 1N4719                                     | CR0251           |
| Q1   | Transistor, 2N3638                                | Q0181            |
| Q2   | Transistor, 2N3646                                | Q0218            |
| Q3   | Transistor, 2N3646                                | Q0218            |
| Q4   | Transistor, 2N3638                                | Q0181            |
| Q5   | Transistor, 2N3646                                | Q0218            |
| R1   | Resistor, 1.8 k, 1/4 W, 5%                        | R0959            |
| R2   | Resistor, 5.6 k, 1/4 W, 5%                        | R0821            |
| R3   | Resistor, 2 k, 1/4 W, 5%                          | R0734            |
| R4   | Resistor, 1 k, .2 W, 20%, Potentiometer           | R2734            |
| R5   | Resistor, 3 k, 1/4 W, 5%                          | R0711            |
| R6   | Resistor, 1 k, 1/4 W, 5%                          | R0765            |
| R7   | Resistor, 1 k, 1/4 W, 5%                          | R0765            |
| R8   | Resistor, 500 $\Omega$ , .2 W, 20%, Potentiometer | R2733            |
| R9   | Resistor, 3 k, 1/4 W, 5%                          | R0711            |
| R10  | Resistor, 3 k, 1/4 W, 5%                          | R0711            |
| R11  | Resistor, 3 k, 1/4 W, 5%                          | R0711            |
| R12  | Resistor, 680 $\Omega$ , 1/4 W, 5%                | R1234            |
| R13  | Resistor, 680 $\Omega$ , 1/4 W, 5%                | R1234            |
| R14  | Resistor, 500 $\Omega$ , .2 W, 20%, Potentiometer | R2733            |
| R15  | Resistor, 2.2 k, 1/4 W, 5%                        | R0749            |
| R16  | Resistor, 680 $\Omega$ , 1/4 W, 5%                | R1234            |
| R17  | Resistor, 500 $\Omega$ , .2 W, 20%, Potentiometer | R2733            |



# MAIN POWER P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                | SD<br>PART NO. |
|------|----------------------------|----------------|
| R18  | Resistor, 2.2 k, 1/4 W, 5% | R0749          |
| R19  | Resistor, 3 k, 1/4 W, 5%   | R0711          |
| R20  | Resistor, 3 k, 1/4 W, 5%   | R0711          |
| R21  | Resistor, 1 k, 1/4 W, 5%   | R0765          |
| R22  | Resistor, 1 k, 1/4 W, 5%   | R0765          |
| R23  | Resistor, 10 k, 1/4 W, 5%  | R0766          |
| TP1  | Test Point, Black          | E0234          |
| TP2  | Test Point, Red            | E0236          |
| TP3  | Test Point, Orange         | E0237          |
| TP4  | Test Point, Yellow         | E0238          |
| TP5  | Test Point, Green          | E0239          |
| U1   | Integrated Circuit, U723C  | 25756          |
| U2   | Integrated Circuit, U723C  | 25756          |
| U3   | Integrated Circuit, U723C  | 25756          |
| U4   | Integrated Circuit, U723C  | 25756          |

# N COMPUTER P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                      | SD<br>PART NO.   |
|------|--------------------------------------------------|------------------|
| A14  | N Computer P.C. Assembly<br>N Computer Schematic | B39375<br>C39372 |
| C1   | Capacitor, .1 $\mu$ F, 35 V, Tant                | C0806            |
| C2   | Capacitor, 1 $\mu$ F, 35 V                       | C0524            |
| C3   | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C4   | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C5   | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C6   | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C7   | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C8   | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C9   | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C10  | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| C11  | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0902            |
| C12  | Capacitor, .05 $\mu$ F, 12 V, Disc               | C0672            |
| L1   | Inductor, R-45-4                                 | L0143            |
| R1   | Resistor, 68 k, 1/4 W, 5%                        | R0891            |
| R2   | Resistor, 470 $\Omega$ , 1/4 W, 5%               | R1044            |
| R3   | Resistor, 330 $\Omega$ , 1/4 W, 5%               | R0662            |
| R4   | Resistor, 1.8 k, 1/4 W, 5%                       | R0959            |
| R5   | Resistor, 560 $\Omega$ , 1/4 W, 5%               | R0819            |
| R6   | Not Used                                         |                  |
| R7   | Resistor, 330 $\Omega$ , 1/4 W, 5%               | R0662            |
| R8   | Resistor, 1 k, 1/4 W, 5%                         | R0765            |
| R9   | Resistor, 330 $\Omega$ , 1/4 W, 5%               | R0662            |
| TP1  | Test Point, Rt Angle, Brown                      | E0235            |
| TP2  | Test Point, Rt Angle, Red                        | E0236            |
| U1   | Integrated Circuit, SN7473N                      | 19709            |
| U2   | Integrated Circuit, SN74193N                     | 25763            |
| U3   | Integrated Circuit, SN74193N                     | 25763            |
| U4   | Integrated Circuit, SN7490N                      | 25732            |
| U5   | Integrated Circuit, SN7474N                      | 25241            |
| U6   | Integrated Circuit, MC1670L                      | 25765            |
| U7   | Integrated Circuit, MC1027P                      | 25719            |
| U8   | Integrated Circuit, MC1027P                      | 25719            |
| U9   | Integrated Circuit, MC1027P                      | 25719            |
| U10  | Integrated Circuit, MC1662L                      | 25778            |
| U11  | Integrated Circuit, SN7400N                      | 19705            |
| U12  | Integrated Circuit, SN15846N                     | 19716            |
| U13  | Integrated Circuit, MC3000                       | 25766            |
| U14  | Integrated Circuit, SN7400N                      | 19705            |
| VR1  | Diode, 3.3 V, 39543                              | A39543           |

# SHIFTER P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                | SD<br>PART NO.   |
|------|--------------------------------------------|------------------|
| A15  | Shifter P.C. Assembly<br>Shifter Schematic | C39371<br>C39368 |
| C1   | Capacitor, .33 $\mu$ F, 100 V              | C0239            |
| C2   | Capacitor, 33 pF, 500 V                    | C0531            |
| C3   | Not Used                                   |                  |
| C4   | Capacitor, 1 $\mu$ F, 25 V                 | C0879            |
| C5   | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C6   | Capacitor, 33 pF, 500 V                    | C0531            |
| C7   | Capacitor, 10 pF, 500 V                    | C0527            |
| C8   | Capacitor, 1 $\mu$ F, 35 V                 | C0524            |
| C9   | Capacitor, 10 pF, 500 V                    | C0527            |
| C10  | Capacitor, .01 $\mu$ F, 100 V              | C0556            |
| C11  | Capacitor, .001 $\mu$ F, 1 kV              | C0235            |
| C12  | Capacitor, .01 $\mu$ F, 100 V              | C0556            |
| C13  | Capacitor, .01 $\mu$ F, 100 V              | C0556            |
| C14  | Capacitor, 22 pF, 500 V                    | C0529            |
| C15  | Capacitor, 150 pF, 500 V                   | C0537            |
| C16  | Capacitor, 150 pF, 500 V                   | C0537            |
| C17  | Capacitor, 159 pF, 500 V                   | C1146            |
| C18  | Capacitor, .047 $\mu$ F, 200 V             | C0700            |
| C19  | Capacitor, 318 pF, 500 V                   | C1145            |
| C20  | Capacitor, 159 pF, 500 V                   | C1146            |
| C21  | Capacitor, 1 $\mu$ F, 35 V                 | C0524            |
| C22  | Capacitor, .033 $\mu$ F, 100 V             | C0735            |
| C23  | Capacitor, 1 $\mu$ F, 35 V                 | C0524            |
| C24  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C25  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C26  | Capacitor, 1 $\mu$ F, 35 V                 | C0524            |
| C27  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C28  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C29  | Capacitor, .01 $\mu$ F, 100 V              | C0556            |
| C30  | Capacitor, 82 pF, 500 V                    | C0535            |
| C31  | Capacitor, .01 $\mu$ F, 100 V              | C0556            |
| C32  | Capacitor, .001 $\mu$ F, 1 kV              | C0235            |
| C33  | Capacitor, .001 $\mu$ F, 1 kV              | C0235            |
| C34  | Capacitor, .01 $\mu$ F, 100 V              | C0556            |
| C35  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C36  | Capacitor, .1 $\mu$ F, 10 V                | C0661            |
| C37  | Capacitor, .1 $\mu$ F, 10 V                | C0661            |
| C38  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C39  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |
| C40  | Capacitor, .05 $\mu$ F, 12 V               | C0672            |

# SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                   | SD<br>PART NO. |
|------|-------------------------------|----------------|
| C41  | Capacitor, .05 $\mu$ F, 12 V  | C0672          |
| C42  | Capacitor, .01 $\mu$ F, 100 V | C0556          |
| C43  | Not Used                      |                |
| C44  | Not Used                      |                |
| C45  | Capacitor, .01 $\mu$ F, 100 V | C0556          |
| C46  | Capacitor, .01 $\mu$ F, 100 V | C0556          |
| C47  | Capacitor, .01 $\mu$ F, 100 V | C0556          |
| C48  | Capacitor, .01 $\mu$ F, 100 V | C0556          |
| C49  | Capacitor, .01 $\mu$ F, 100 V | C0556          |
| CR1  | Diode, 1N4151                 | CR0150         |
| CR2  | Diode, 1N4151                 | CR0150         |
| CR3  | Not Used                      |                |
| CR4  | Diode, MV2108                 | CR0354         |
| CR5  | Diode, MV2108                 | CR0354         |
| CR6  | Diode, HPA2800                | CR0363         |
| CR7  | Diode, 1N4151                 | CR0150         |
| CR8  | Diode, 1N4151                 | CR0150         |
| VR1  | Diode, Breakdown, 1N965B      | CR0139         |
| VR2  | Diode, Breakdown, FZ902       | 26015850       |
| J18  | Socket, I.C., 14 Pin          | X0186          |
| L1   | Inductor, 10 $\mu$ H          | L0153          |
| L2   | Inductor, P/O Artwork         |                |
| L3   | Inductor, 2.7 $\mu$ H         | L0165          |
| L4   | Inductor, .05 $\mu$ H         | L0159          |
| L5   | Inductor, 2.7 $\mu$ H         | L0165          |
| L6   | Inductor, .82 $\mu$ H         | L0163          |
| L7   | Inductor, 2.7 $\mu$ H         | L0165          |
| L8   | Inductor, 2.7 $\mu$ H         | L0165          |
| L9   | Inductor, 2.7 $\mu$ H         | L0165          |
| L10  | Inductor, .82 $\mu$ H         | L0163          |
| L11  | Inductor, 100 $\mu$ H         | L0156          |
| Q1   | Transistor, 2N3646            | Q0218          |
| Q2   | Transistor, 2N3646            | Q0218          |
| Q3   | Transistor, 2N3565            | Q0237          |
| Q4   | Transistor, 40673             | Q0297          |
| Q5   | Transistor, 2N5179            | Q0269          |
| Q6   | Transistor, 2N4342            | Q0243          |
| Q7   | Transistor, 2N3565            | Q0237          |
| Q8   | Transistor, 2N3565            | Q0237          |
| Q9   | Transistor, 2N3565            | Q0237          |

# SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R1   | Resistor, 4.7 k, 1/8 W, 5%         | R1733          |
| R2   | Resistor, 3.3 k, 1/8 W, 5%         | R1456          |
| R3   | Resistor, 22 $\Omega$ , 1/4 W, 5%  | R1436          |
| R4   | Resistor, 220 k, 1/4 W, 5%         | R0967          |
| R5   | Resistor, 10 k, 1/8 W, 5%          | R1437          |
| R6   | Resistor, 22 k, 1/8 W, 5%          | R1742          |
| R7   | Resistor, 10 k, 1/8 W, 5%          | R1437          |
| R8   | Resistor, 1 k, 1/8 W, 5%           | R1453          |
| R9   | Resistor, 47 k, 1/8 W, 5%          | R1433          |
| R10  | Resistor, 15 k, 1/8 W, 5%          | R1438          |
| R11  | Resistor, 47 k, 1/8 W, 5%          | R1433          |
| R12  | Resistor, 4.7 k, 1/8 W, 5%         | R1733          |
| R13  | Resistor, 100 $\Omega$ , 1/8 W, 5% | R1441          |
| R14  | Resistor, 22 k, 1/8 W, 5%          | R1742          |
| R15  | Resistor, 91 k, 1/8 W, 5%          | R2852          |
| R16  | Resistor, 22 k, 1/8 W, 5%          | R1742          |
| R17  | Resistor, 47 k, 1/8 W, 5%          | R1433          |
| R18  | Resistor, 2.2 k, 1/8 W, 5%         | R1476          |
| R19  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R20  | Resistor, 6.8 k, 1/8 W, 5%         | R1459          |
| R21  | Resistor, 4.7 k, 1/8 W, 5%         | R1733          |
| R22  | Resistor, 390 $\Omega$ , 1/8 W, 5% | R1450          |
| R23  | Resistor, 15 $\Omega$ , 1/8 W, 5%  | R1867          |
| R24  | Resistor, 100 $\Omega$ , 1/8 W, 5% | R1441          |
| R25  | Resistor, 15 k, 1/8 W, 5%          | R1438          |
| R26  | Resistor, 1 M, 1/8 W, 1%           | R2371          |
| R27  | Resistor, 12 k, 1/8 W, 5%          | R2464          |
| R28  | Resistor, 499 k, 1/8 W, 1%         | R2372          |
| R29  | Resistor, 1 M, 1/8 W, 1%           | R2371          |
| R30  | Resistor, 3.3 k, 1/4 W, 5%         | R0742          |
| R31  | Resistor, 10 k, 1/8 W, 5%          | R1437          |
| R32  | Resistor, 470 $\Omega$ , 1/8 W, 5% | R1451          |
| R33  | Resistor, 5.6 k, 1/8 W, 5%         | R1458          |
| R34  | Resistor, 820 $\Omega$ , 1/8 W, 5% | R2462          |
| R35  | Resistor, 4.7 k, 1/8 W, 5%         | R1733          |
| R36  | Resistor, 1 k, 1/8 W, 5%           | R1453          |
| R37  | Resistor, 820 $\Omega$ , 1/8 W, 5% | R2462          |
| R38  | Resistor, 1 k, 1/8 W, 5%           | R1453          |
| R39  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R40  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |



# SHIFTER P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R41  | Resistor, 39 $\Omega$ , 1/8 W, 5%  | R1829          |
| R42  | Resistor, 560 $\Omega$ , 1/8 W, 5% | R1452          |
| R43  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R44  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R45  | Resistor, 39 $\Omega$ , 1/8 W, 5%  | R1829          |
| R46  | Resistor, 560 $\Omega$ , 1/8 W, 5% | R1452          |
| R47  | Resistor, 6.8 k, 1/8 W, 5%         | R1459          |
| R48  | Resistor, 6.8 k, 1/8 W, 5%         | R1459          |
| R49  | Resistor, 120 $\Omega$ , 1/8 W, 5% | R2459          |
| R50  | Resistor, 120 $\Omega$ , 1/8 W, 5% | R2459          |
| R51  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R52  | Resistor, 220 $\Omega$ , 1/8 W, 5% | R1743          |
| R53  | Resistor, 330 $\Omega$ , 1/8 W, 5% | R1444          |
| R54  | Resistor, 2.2 k, 1/8 W, 5%         | R1476          |
| R55  | Resistor, 5 k, Potentiometer       | R2187          |
| R56  | Resistor, 100 $\Omega$ , 1/8 W, 5% | R1441          |
| TP1  | Test Point, Brown                  | E0235          |
| U1   | Integrated Circuit, LM301A         | 25745          |
| U2   | Integrated Circuit, CA3026         | 25724          |
| U3   | Integrated Circuit, CA3028A        | 25702          |

# 200 MHz AMP. P.C. ASSEMBLY PARTS LIST

| REF. | DESCRIPTION                                          | SD<br>PART NO.   |
|------|------------------------------------------------------|------------------|
| A16  | 200 MHz Amp. P.C. Assembly<br>200 MHz Amp. Schematic | B39323<br>C39320 |
| C1   | Capacitor, .001 $\mu$ F, 1 kV                        | C0235            |
| C2   | Capacitor, .01 $\mu$ F, 100 V                        | C0556            |
| C3   | Capacitor, .01 $\mu$ F, 100 V                        | C0556            |
| C4   | Capacitor, .1 $\mu$ F, 10 V                          | C0661            |
| C5   | Capacitor, .001 $\mu$ F, 75 V                        | C1155            |
| C6   | Capacitor, .1 $\mu$ F, 10 V                          | C0661            |
| C7   | Capacitor, .1 $\mu$ F, 10 V                          | C0661            |
| C8   | Capacitor, .01 $\mu$ F, 100 V                        | C0556            |
| C9   | Capacitor, .01 $\mu$ F, 100 V                        | C0556            |
| C10  | Capacitor, .01 $\mu$ F, 100 V                        | C0556            |
| C11  | Capacitor, .001 $\mu$ F, 75 V                        | C1155            |
| C12  | Capacitor, .01 $\mu$ F, 100 V                        | C0556            |
| C13  | Capacitor, 15 pF, 500 V                              | C0528            |
| C14  | Not Used                                             |                  |
| C15  | Capacitor, .001 $\mu$ F, 1 kV                        | C0235            |
| CR1  | Diode, 1N4151                                        | CR0150           |
| CR2  | Diode, 1N4151                                        | CR0150           |
| CR3  | Diode, 1N4151                                        | CR0150           |
| CR4  | Diode, 1N4151                                        | CR0150           |
| CR5  | Diode, 1N4151                                        | CR0150           |
| CR6  | Not Used                                             |                  |
| CR7  | Not Used                                             |                  |
| CR8  | Diode, 1N4151                                        | CR0150           |
| L1   | Coil, Reed                                           | L0169            |
| L2   | Coil, Reed                                           | L0174            |
| L3   | Coil, Reed                                           | L0174            |
| L4   | Inductor, 270 $\mu$ H                                | L0067            |
| L5   | Inductor, R.F., R45-4                                | L0143            |
| L6   | Inductor, .06 $\mu$ H                                | L0158            |
| Q1   | Transistor, SD A39843                                | A39843           |
| Q2   | Transistor, 2N2907                                   | Q0174            |
| Q3   | Transistor, MM4049                                   | Q0303            |
| Q4   | Transistor, MM4049                                   | Q0303            |
| Q5   | Transistor, 2N5179                                   | Q0269            |
| Q6   | Transistor, 2N5179                                   | Q0269            |
| Q7   | Transistor, 2N5179                                   | Q0269            |
| Q8   | Transistor, 2N3640                                   | Q0178            |
| Q9   | Transistor, 2N4959                                   | Q0274            |
| Q10  | Transistor, 2N4959                                   | Q0274            |

## 200 MHz AMP. P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                            | SD<br>PART NO. |
|------|----------------------------------------|----------------|
| R1   | Resistor, 100 k, 1/2 W, 5%             | R0352          |
| R2   | Resistor, 390 $\Omega$ , 1/4 W, 5%     | R0880          |
| R3   | Resistor, 330 $\Omega$ , 1/8 W, 5%     | R1444          |
| R4   | Resistor, 100 $\Omega$ , 1/4 W, 5%     | R0966          |
| R5   | Resistor, 100 $\Omega$ , 1/4 W, 5%     | R0966          |
| R6   | Resistor, 390 $\Omega$ , 1/4 W, 5%     | R0880          |
| R7   | Resistor, 560 $\Omega$ , 1/4 W, 5%     | R0819          |
| R8   | Resistor, 2.2 k, 1/4 W, 5%             | R0749          |
| R9   | Resistor, 200 $\Omega$ , Potentiometer | R2705          |
| R10  | Resistor, 560 $\Omega$ , 1/4 W, 5%     | R0819          |
| R11  | Resistor, 330 $\Omega$ , 1/8 W, 5%     | R1444          |
| R12  | Resistor, 270 $\Omega$ , 1/4 W, 5%     | R0694          |
| R13  | Resistor, 2 k, Potentiometer           | R2704          |
| R14  | Resistor, 2.2 k, 1/8 W, 5%             | R1476          |
| R15  | Resistor, 2.7 k, 1/8 W, 5%             | R1749          |
| R16  | Resistor, 220 $\Omega$ , 1/8 W, 5%     | R2732          |
| R17  | Resistor, 1 M, 1/4 W, 5%               | R0962          |
| R18  | Not Used                               |                |
| R19  | Resistor, 56 $\Omega$ , 1/4 W, 5%      | R1554          |
| R20  | Resistor, 100 $\Omega$ , 1/4 W, 5%     | R0966          |
| R21  | Resistor, 820 $\Omega$ , 1/4 W, 5%     | R0762          |
| R22  | Resistor, 390 $\Omega$ , 1/4 W, 5%     | R0880          |
| R23  | Resistor, 100 $\Omega$ , 1/4 W, 5%     | R0966          |
| R24  | Resistor, 390 $\Omega$ , 1/4 W, 5%     | R0880          |
| R25  | Resistor, 2.2 k, 1/4 W, 5%             | R0749          |
| R26  | Resistor, 390 $\Omega$ , 1/4 W, 5%     | R0880          |
| R27  | Resistor, 47 $\Omega$ , 1/4 W, 5%      | R0743          |
| R28  | Resistor, 1 k, 1/4 W, 5%               | R0765          |
| R29  | Resistor, 220 $\Omega$ , 1/4 W, 5%     | R0760          |
| R30  | Resistor, 620 $\Omega$ , 1/8 W, 5%     | 02395630       |
| R31  | Resistor, 620 $\Omega$ , 1/4 W, 5%     | R1334          |
| R32  | Resistor, 220 $\Omega$ , 1/8 W, 5%     | R1743          |
| R33  | Resistor, 4.7 k, 1/4 W, 5%             | R0892          |
| R34  | Resistor, 4.7 k, 1/4 W, 5%             | R0892          |
| R35  | Resistor, 560 $\Omega$ , 1/4 W, 5%     | R0819          |
| R36  | Resistor, 560 $\Omega$ , 1/4 W, 5%     | R0819          |
| S1   | Switch, Reed                           | A37288         |
| S2   | Switch, Reed                           | S0400          |
| S3   | Switch, Reed                           | S0400          |
| U1   | Integrated Circuit, MC1662L            | 25778          |

# 10 MHz AMPLIFIER P.C. ASSEMBLY PARTS LIST

| REF.     | DESCRIPTION                                                  | SD<br>PART NO.   |
|----------|--------------------------------------------------------------|------------------|
| A18, A19 | 10 MHz Amplifier P.C. Assembly<br>10 MHz Amplifier Schematic | B39331<br>C39328 |
| C1       | Capacitor, .05 $\mu$ F, 500 V                                | C0422            |
| C2       | Capacitor, 12 pF, 500 V                                      | C0637            |
| C3       | Capacitor, 100 pF, 500 V                                     | C0536            |
| C4       | Capacitor, 100 pF, 500 V                                     | C0536            |
| C5       | Capacitor, 1000 pF, 100 V                                    | C0543            |
| C6       | Capacitor, 33 pF, 500 V                                      | C0531            |
| C7       | Capacitor, 180 pF, 500 V                                     | C0707            |
| C8       | Capacitor, .01 $\mu$ F, 100 V                                | C0556            |
| C9       | Capacitor, .01 $\mu$ F, 100 V                                | C0556            |
| C10      | Capacitor, .01 $\mu$ F, 100 V                                | C0556            |
| C11      | Capacitor, .01 $\mu$ F, 100 V                                | C0556            |
| C12      | Capacitor, .01 $\mu$ F, 100 V                                | C0556            |
| C13      | Capacitor, .01 $\mu$ F, 100 V                                | C0556            |
| C14      | Capacitor, 220 pF, 500 V                                     | C0538            |
| C15      | Capacitor, .001 $\mu$ F, 1 kV                                | C0235            |
| C16      | Capacitor, .05 $\mu$ F, 12 V                                 | C0672            |
| C17      | Not Used                                                     |                  |
| C18      | Capacitor, 33 pF, 500 V                                      | C0531            |
| C19      | Capacitor, .001 $\mu$ F, 1 kV                                | C0235            |
| CR1      | Diode, 1N4151                                                | CR0150           |
| CR2      | Diode, 1N4151                                                | CR0150           |
| CR3      | Diode, 1N4151                                                | CR0150           |
| CR4      | Diode, 1N4151                                                | CR0150           |
| CR5      | Diode, 1N4151                                                | CR0150           |
| CR6      | Diode, 1N4151                                                | CR0150           |
| CR7      | Diode, 1N4151                                                | CR0150           |
| K1       | Relay, Reed, Form A, 1 kV                                    | K0132            |
| K2       | Relay, Reed, Form A, 1 kV                                    | K0132            |
| K3       | Relay, Reed, Form A, 250 V                                   | K0133            |
| K4       | Relay, Reed, Form A, 250 V                                   | K0133            |
| Q1       | Transistor, Dual FET                                         | 39843            |
| Q2       | Transistor, 2N4275                                           | 26013140         |
| Q3       | Transistor, 2N4275                                           | 26013140         |
| Q4       | Transistor, 2N4258                                           | 26004011         |
| Q5       | Transistor, 2N4258                                           | 26004011         |
| Q6       | Transistor, 2N4258                                           | 26004011         |
| Q7       | Transistor, 2N4258                                           | 26004011         |
| Q8       | Transistor, 2N4275                                           | 26013140         |

## 10 MHz AMPLIFIER P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| Q9   | Transistor, 2N4275                 | 26013140       |
| Q10  | Transistor, 2N4258                 | 26004011       |
| Q11  | Transistor, 2N4258                 | 26004011       |
| Q12  | Transistor, 2N3646                 | Q0218          |
| Q13  | Transistor, 2N3646                 | Q0218          |
| R1   | Resistor, 820 k, 1/4 W, 5%         | R2153          |
| R2   | Resistor, 910 k, 1/4 W, 5%         | R2312          |
| R3   | Resistor, 91 k, 1/4 W, 5%          | R1481          |
| R4   | Resistor, 100 k, 1/4 W, 5%         | R0741          |
| R5   | Resistor, 11 k, 1/4 W, 5%          | R1582          |
| R6   | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R7   | Resistor, 1 k, Potentiometer       | R2330          |
| R8   | Resistor, 200 $\Omega$ , 1/4 W, 5% | R0736          |
| R9   | Resistor, 200 $\Omega$ , 1/4 W, 5% | R0736          |
| R10  | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R11  | Resistor, 10 $\Omega$ , 1/4 W, 5%  | R0739          |
| R12  | Resistor, 10 k, 1/4 W, 5%          | R0766          |
| R13  | Resistor, 1 M, 1/4 W, 5%           | R0962          |
| R14  | Resistor, 1.5 k, 1/4 W, 5%         | R0783          |
| R15  | Resistor, 1.5 k, 1/4 W, 5%         | R0783          |
| R16  | Resistor, 100 $\Omega$ , 1/4 W, 5% | R0966          |
| R17  | Resistor, 680 $\Omega$ , 1/4 W, 5% | R1234          |
| R18  | Resistor, 1.5 k, 1/4 W, 5%         | R0783          |
| R19  | Resistor, 1.5 k, 1/4 W, 5%         | R0783          |
| R20  | Resistor, 680 $\Omega$ , 1/4 W, 5% | R1234          |
| R21  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R22  | Resistor, 3.3 k, 1/4 W, 5%         | R0742          |
| R23  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R24  | Resistor, 680 $\Omega$ , 1/4 W, 5% | R1234          |
| R25  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R26  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R27  | Resistor, 680 $\Omega$ , 1/4 W, 5% | R1234          |
| R28  | Resistor, 5.6 k, 1/4 W, 5%         | R0821          |
| R29  | Resistor, 2.2 k, 1/4 W, 5%         | R0749          |
| R30  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R31  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R32  | Resistor, 5.6 k, 1/4 W, 5%         | R0821          |
| R33  | Resistor, 56 $\Omega$ , 1/4 W, 5%  | R1554          |
| R34  | Resistor, 56 $\Omega$ , 1/4 W, 5%  | R1554          |
| R35  | Resistor, 360 $\Omega$ , 1/4 W, 5% | R1571          |
| R36  | Resistor, 5.6 k, 1/4 W, 5%         | R0821          |
| R37  | Resistor, 5.6 k, 1/4 W, 5%         | R0821          |



# 10 MHz AMPLIFIER P.C. ASSEMBLY PARTS LIST (Cont'd)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R38  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R39  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R40  | Resistor, 1 k, 1/4 W, 5%           | R0765          |
| R41  | Resistor, 5.6 k, 1/4 W, 5%         | R0821          |
| R42  | Resistor, 100 $\Omega$ , 1/4 W, 5% | R0966          |
| R43  | Resistor, 2.2k, 1/8 W, 5%          | R1476          |
| R44  | Resistor, 4.7 k, 1/4 W, 5%         | R0892          |
| R45  | Resistor, 2.7 k, 1/4 W, 5%         | R0937          |
| R46  | Resistor, 2.7 k, 1/8 W, 5%         | R1749          |
| R47  | Resistor, 10 $\Omega$ , 1/4 W, 5%  | R0739          |
| R48  | Resistor, 10 k, 1/4 W, 5%          | R0766          |
| R49  | Resistor, 2.2 k, 1/8 W, 5%         | R1476          |
| R50  | Resistor, 2.7 k, 1/8 W, 5%         | R1749          |
| U1   | Integrated Circuit, 7400N          | 19705          |
| U2   | Integrated Circuit, 7400N          | 19705          |
| VR1  | Diode, Breakdown, S20266           | 26003501       |
| VR2  | Diode, Breakdown, S20266           | 26003501       |
| VR3  | Diode, Breakdown, 1N957B           | CR0292         |
| VR4  | Diode, Breakdown, 1N957B           | CR0292         |

# MIXER P.C. ASSEMBLY

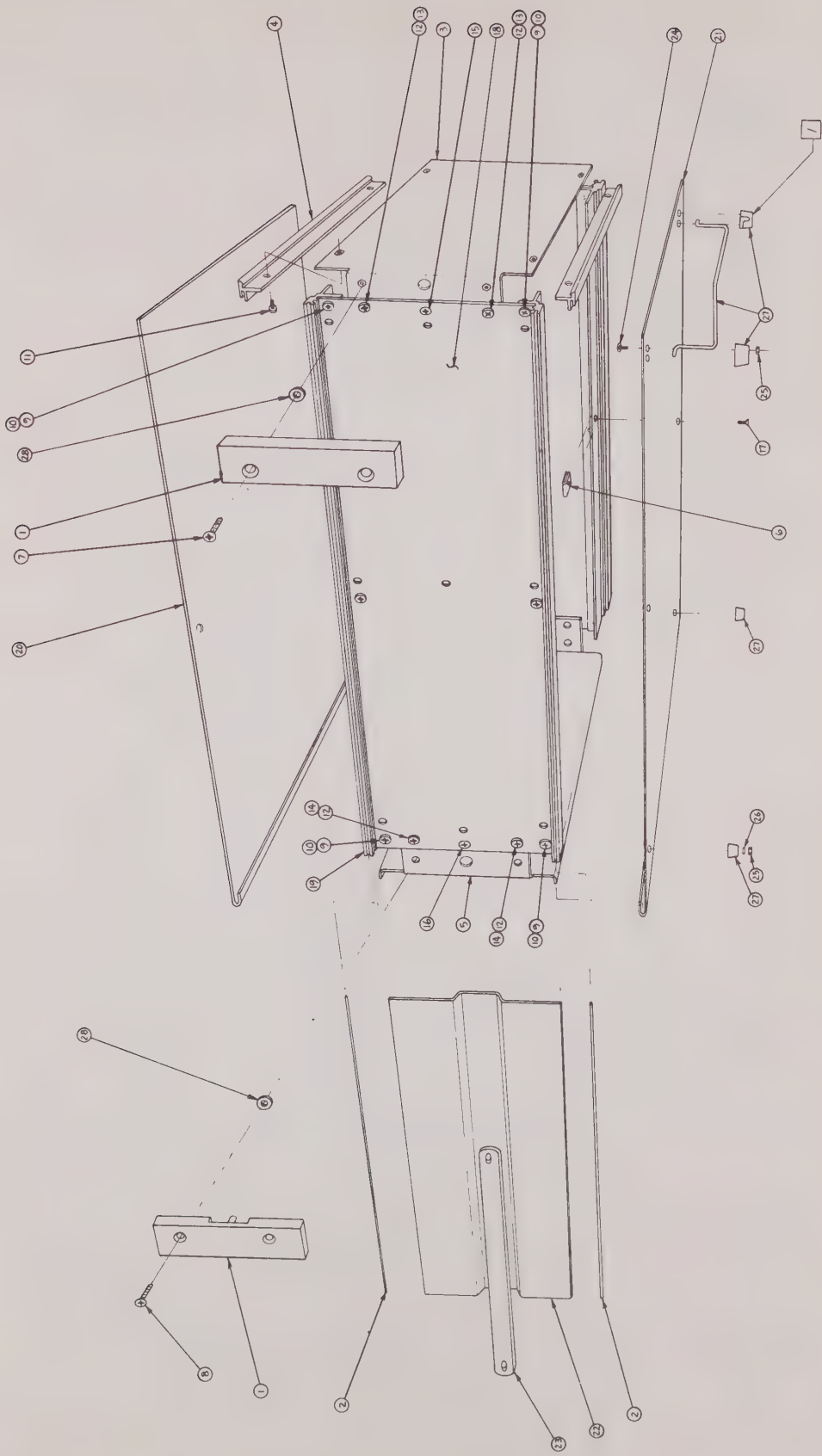
| REF. | DESCRIPTION                            | SD<br>PART NO.   |
|------|----------------------------------------|------------------|
| A20  | Mixer P.C. Assembly<br>Mixer Schematic | C33218<br>C27988 |
| C1   | Capacitor, 5 pF, Chip                  | C1187            |
| C2   | Capacitor, 5 pF, Chip                  | C1187            |
| C3   | Capacitor, .005 $\mu$ F, Chip          | C1245            |
| C4   | Capacitor, 5 pF, Chip                  | C1187            |
| C5   | Capacitor, 5 pF, Chip                  | C1187            |
| C6   | Capacitor, .01 $\mu$ F, 100 V, Disc    | C0556            |
| C7   | Capacitor, 22 pF, Chip                 | C1177            |
| C8   | Capacitor, .01 $\mu$ F, 100 V, Disc    | C0556            |
| C9   | Capacitor, .01 $\mu$ F, 100 V, Disc    | C0556            |
| C10  | Capacitor, 56 pF, 500 V, DM            | C0882            |
| C11  | Capacitor, 56 pF, 500 V, DM            | C0882            |
| C12  | Capacitor, 100 pF, 500 V, DM           | C0536            |
| C13  | Capacitor, .01 $\mu$ F, 100 V, Disc    | C0556            |
| C14  | Capacitor, .1 $\mu$ F, 10 V, Disc      | C0661            |
| C15  | Capacitor, .05 $\mu$ F, 12 V, Disc     | C0672            |
| C16  | Capacitor, 180 pF, 500 V, DM           | C1138            |
| C17  | Capacitor, .05 $\mu$ F, 12 V, Disc     | C0672            |
| C18  | Not Used                               |                  |
| C19  | Not Used                               |                  |
| C20  | Capacitor, 1 $\mu$ F, 35 V, Tant       | C0524            |
| C21  | Capacitor, .05 $\mu$ F, 12 V, Disc     | C0672            |
| CR1  | Diode, HPA-5082-2542                   | CR0358           |
| CR2  | Diode, HPA-5082-2542                   | CR0358           |
| CR3  | Diode, HPA-5082-2542                   | CR0358           |
| CR4  | Diode, HPA-5082-2542                   | CR0358           |
| CR5  | Diode, HPA-5082-2542                   | CR0358           |
| CR6  | Diode, HPA 5082-2800                   | CR0363           |
| CR7  | Diode, 1N4151                          | CR0150           |
| CR8  | Diode, 1N4151                          | CR0150           |
| CR9  | Diode, 1N4151                          | CR0150           |
| Q1   | Transistor, 2N3958                     | 26015100         |
| Q2   | Transistor, 2N5459                     | Q0264            |
| Q3   | Transistor, SD Spec 33392              | 33392            |
| R1   | Resistor, 50 $\Omega$ , Chip           | R2494            |
| R2   | Resistor, 50 $\Omega$ , Chip           | R2494            |
| R3   | Resistor, 50 $\Omega$ , Chip           | R2494            |
| R4   | Resistor, 50 $\Omega$ , Chip           | R2494            |
| R5   | Resistor, 150 k, 1/4 W, 1%, MF         | R2421            |

# MIXER P.C. ASSEMBLY (Cont'd)

| REF. | DESCRIPTION                          | SD<br>PART NO. |
|------|--------------------------------------|----------------|
| R6   | Resistor, 150 k, 1/4 W, 1%, MF       | R2421          |
| R7   | Resistor, 150 k, 1/4 W, 1%, MF       | R2421          |
| R8   | Resistor, 150 k, 1/4 W, 1%, MF       | R2421          |
| R9   | Resistor, 50 $\Omega$ , Chip         | R2494          |
| R10  | Resistor, 560 k, 1/8 W, 5%           | R2536          |
| R11  | Resistor, 1 M, 1/8 W, 5%             | R1435          |
| R12  | Resistor, 10 k, 1/8 W, 5%            | R1437          |
| R13  | Resistor, 2.7 k, 1/8 W, 5%           | R1749          |
| R14  | Resistor, 27 k, 1/8 W, 5%            | R2432          |
| R15  | Resistor, 2.7 k, 1/8 W, 5%           | R1749          |
| R16  | Resistor, 27 k, 1/8 W, 5%            | R2432          |
| R17  | Resistor, 5 k, Potentiometer, 4 Turn | R2697          |
| R18  | Not Used                             |                |
| R19  | Resistor, 5 k, Potentiometer, 4 Turn | R2697          |
| R20  | Resistor, 2.2 k, 1/8 W, 5%           | R1476          |
| R21  | Resistor, 2.2 k, 1/8 W, 5%           | R1476          |
| R22  | Resistor, 330 k, 1/8 W, 5%           | R2535          |
| R23  | Resistor, 1 k, 1/8 W, 5%             | R1453          |
| R24  | Resistor, 2.4 k, 1/8 W, 5%           | R2358          |
| R25  | Resistor, 2.7 k, 1/8 W, 5%           | R1749          |
| R26  | Resistor, 1 k, 1/8 W, 5%             | R1453          |
| R27  | Resistor, 1 k, 1/8 W, 5%             | R1453          |
| R28  | Resistor, 3.9 k, 1/8 W, 5%           | R1457          |
| R29  | Resistor, 390 $\Omega$ , 1/8 W, 5%   | R1450          |
| R30  | Resistor, 4.7 k, 1/8 W, 5%           | R1733          |
| R31  | Resistor, 680 $\Omega$ , 1/8 W, 5%   | R2461          |
| R32  | Resistor, 3.3 k, 1/8 W, 5%           | R1456          |
| R33  | Resistor, 10 k, 1/8 W, 5%            | R1437          |
| R34  | Resistor, 10 k, 1/8 W, 5%            | R1437          |
| R35  | Resistor, 6.8 k, 1/8 W, 5%           | R1459          |
| R36  | Resistor, Selected                   | Rxxxx          |
| R37  | Resistor, 3.3 k, 1/8 W, 5%           | R1456          |
| R38  | Resistor, 100 k, 1/8 W, 5%           | R2465          |
| R39  | Resistor, 1 k, 1/8 W, 5%             | R1453          |
| R40  | Resistor, 100 k, 1/8 W, 5%           | R2465          |
| R41  | Resistor, 1 k, 1/8 W, 5%             | R1453          |
| R42  | Resistor, 680 $\Omega$ , 1/8 W, 5%   | R2461          |
| R43  | Resistor, 4.7 k, 1/8 W, 5%           | R1733          |
| U1   | Integrated Circuit, CA3029           | 25757          |
| U2   | Integrated Circuit, LM301A           | 25745          |
| U3   | Integrated Circuit, CA3046           | 25725          |

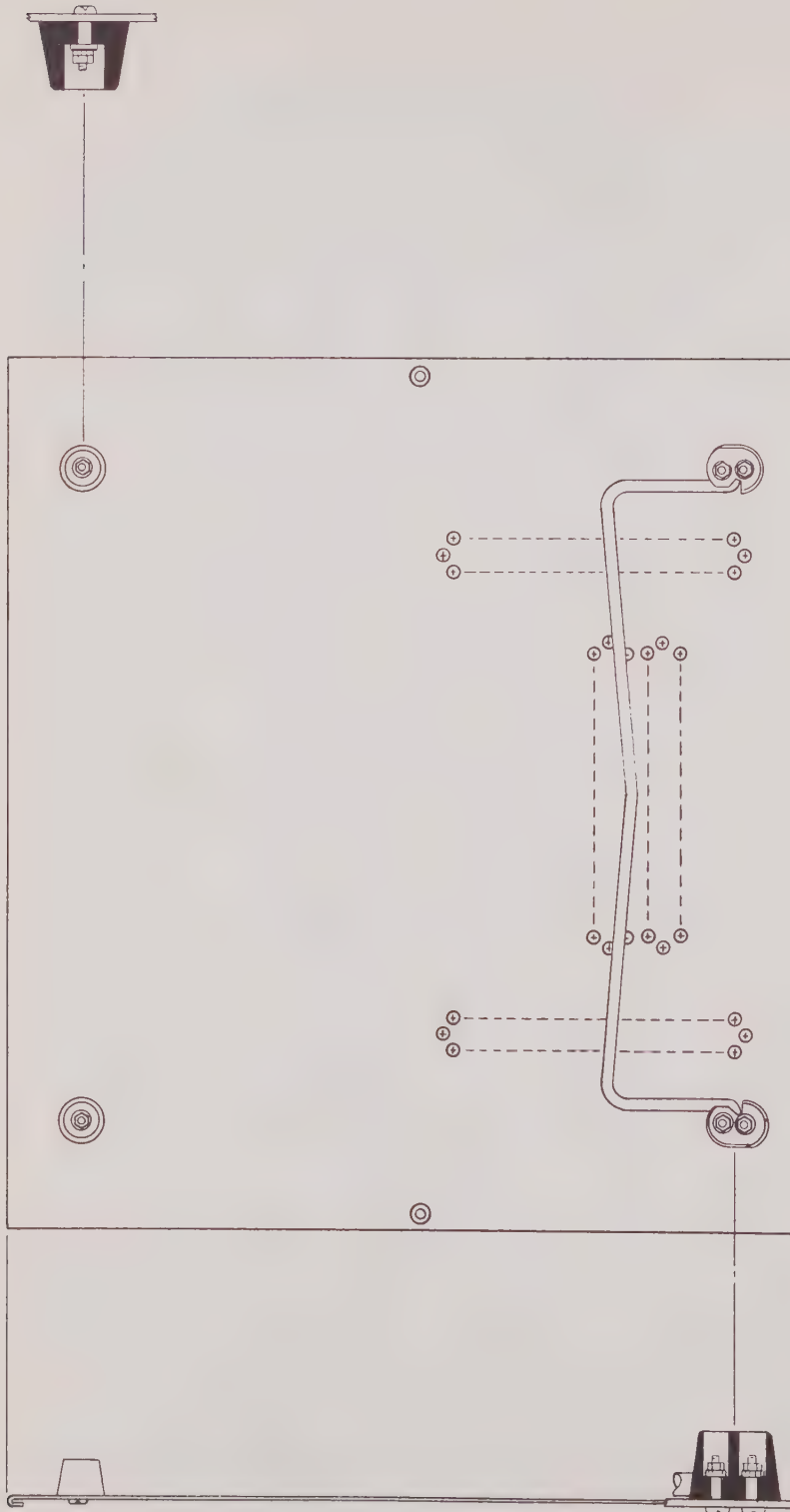
# DRIVER AMPLIFIER P.C. ASSEMBLY

| REF.  | DESCRIPTION                                                  | SD<br>PART NO. |
|-------|--------------------------------------------------------------|----------------|
| A20   | Driver Amplifier P.C. Assembly<br>Driver Amplifier Schematic | C33221         |
| C101  | Capacitor, 15 pF, Chip                                       | C1163          |
| C102  | Capacitor, 15 pF, Chip                                       | C1163          |
| C103  | Capacitor, 22 pF, Chip                                       | C1177          |
| C104  | Capacitor, 15 pF, Chip                                       | C1163          |
| C105  | Capacitor, 15 pF, Chip                                       | C1163          |
| C106  | Capacitor, 22 pF, Chip                                       | C1177          |
| C107  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672          |
| C108  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672          |
| C109  | Not Used                                                     |                |
| C110  | Not Used                                                     |                |
| C111  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672          |
| C112  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672          |
| C113  | Capacitor, 100 $\mu$ F, 10 V                                 | C0660          |
| C114  | Capacitor, .05 $\mu$ F, 12 V                                 | C0672          |
| C115  | Capacitor, 68 pF, 500 V                                      | C0635          |
| C116  | Capacitor, 68 pF, 500 V                                      | C0635          |
| C117  | Capacitor, 100 $\mu$ F, 10 V                                 | C0660          |
| CR101 | Diode, HP0151                                                | CR0269         |
| CR102 | Diode, HP0151                                                | CR0269         |
| L101  | Inductor, 100 $\mu$ H, 10%                                   | L0073          |
| L102  | Inductor, 100 $\mu$ H, 10%                                   | L0073          |
| Q101  | Transistor, 2N3646                                           | Q0218          |
| Q102  | Transistor, 2N3646                                           | Q0218          |
| Q103  | Transistor, 2N3646                                           | Q0218          |
| Q104  | Transistor, 2N3646                                           | Q0218          |
| Q105  | Transistor, 2N3640                                           | Q0178          |
| Q106  | Transistor, 2N3640                                           | Q0178          |
| R101  | Resistor, 150 $\Omega$ , 5%, 1/4 W                           | R0983          |
| R102  | Resistor, 150 $\Omega$ , 5%, 1/4 W                           | R0983          |
| R103  | Resistor, 150 $\Omega$ , 5%, 1/4 W                           | R0983          |
| R104  | Resistor, 270 $\Omega$ , 5%, 1/4 W                           | R0694          |
| R105  | Resistor, 47 $\Omega$ , 5%, 1/4 W                            | R0743          |
| R106  | Resistor, 47 $\Omega$ , 5%, 1/4 W                            | R0743          |
| R107  | Resistor, 330 $\Omega$ , 5%, 1/4 W                           | R0662          |
| R108  | Resistor, 330 $\Omega$ , 5%, 1/4 W                           | R0662          |
| R109  | Resistor, 470 $\Omega$ , 5%, 1/4 W                           | R1044          |
| R110  | Resistor, 1 k, 5%, 1/4 W                                     | R0765          |

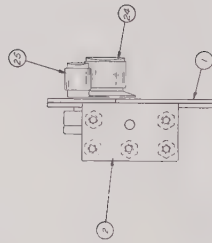
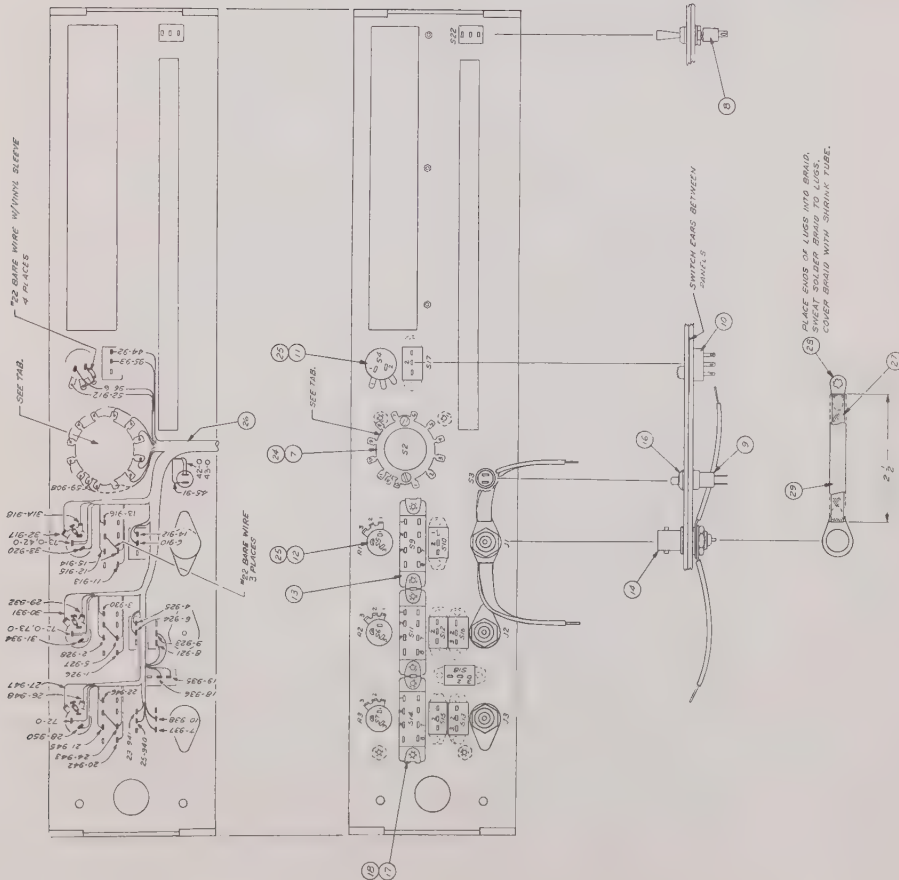


MODEL 6153-50 FINAL CABINET ASSEMBLY





BOTTOM COVER ASSEMBLY #C39644A



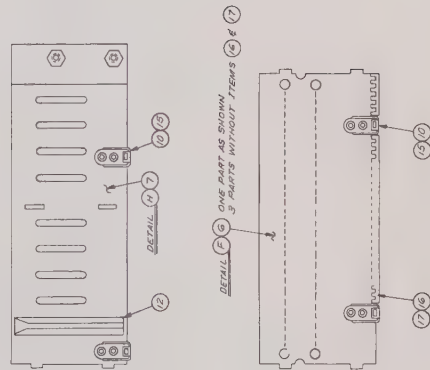
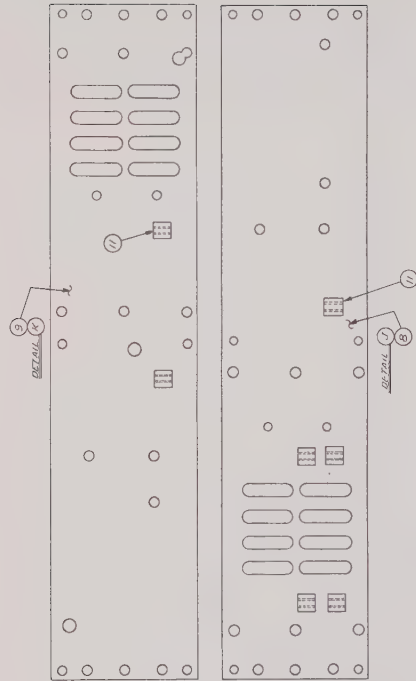
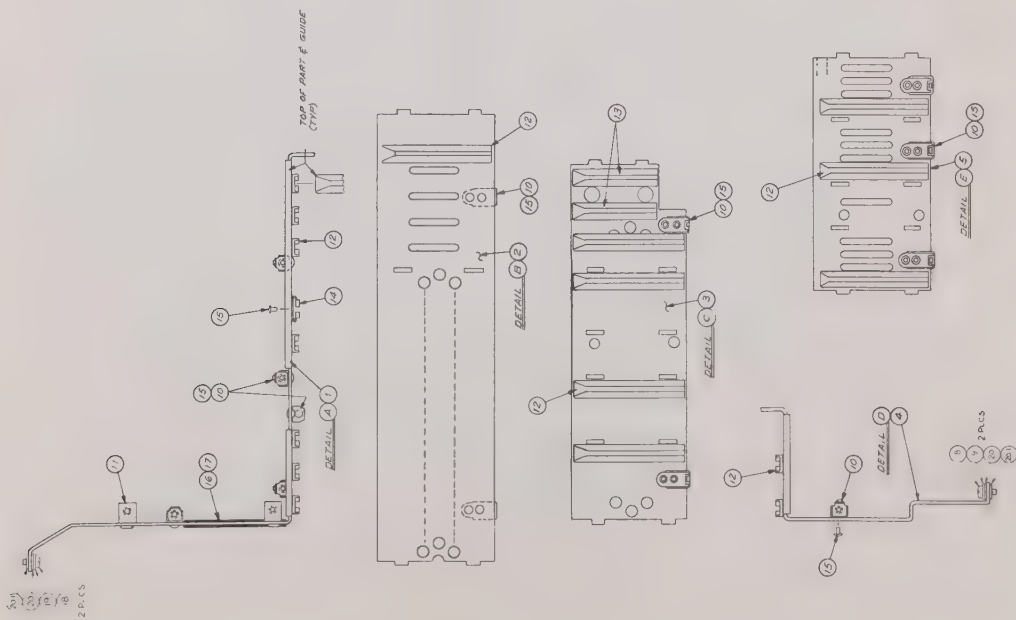
| QTY | PART NUMBER | DESCRIPTION            | UNIT PRICE | TOTAL PRICE |
|-----|-------------|------------------------|------------|-------------|
| 1   | 3052        | SHRINK TUBE (2' LONG)  |            |             |
| 2   | 3053        | BRAID                  |            |             |
| 3   | 3054        | FRONT PANEL CABLE ASSY |            |             |
| 4   | 3055        | WIRE, ROUND            |            |             |
| 5   | 3056        | WIRE, BARE             |            |             |
| 6   | 3057        | WIRE, BARE             |            |             |
| 7   | 3058        | WIRE, BARE             |            |             |
| 8   | 3059        | WIRE, BARE             |            |             |
| 9   | 3060        | WIRE, BARE             |            |             |
| 10  | 3061        | WIRE, BARE             |            |             |
| 11  | 3062        | WIRE, BARE             |            |             |
| 12  | 3063        | WIRE, BARE             |            |             |
| 13  | 3064        | WIRE, BARE             |            |             |
| 14  | 3065        | WIRE, BARE             |            |             |
| 15  | 3066        | WIRE, BARE             |            |             |
| 16  | 3067        | WIRE, BARE             |            |             |
| 17  | 3068        | WIRE, BARE             |            |             |
| 18  | 3069        | WIRE, BARE             |            |             |
| 19  | 3070        | WIRE, BARE             |            |             |
| 20  | 3071        | WIRE, BARE             |            |             |
| 21  | 3072        | WIRE, BARE             |            |             |
| 22  | 3073        | WIRE, BARE             |            |             |
| 23  | 3074        | WIRE, BARE             |            |             |
| 24  | 3075        | WIRE, BARE             |            |             |
| 25  | 3076        | WIRE, BARE             |            |             |
| 26  | 3077        | WIRE, BARE             |            |             |
| 27  | 3078        | WIRE, BARE             |            |             |
| 28  | 3079        | WIRE, BARE             |            |             |
| 29  | 3080        | WIRE, BARE             |            |             |
| 30  | 3081        | WIRE, BARE             |            |             |
| 31  | 3082        | WIRE, BARE             |            |             |
| 32  | 3083        | WIRE, BARE             |            |             |
| 33  | 3084        | WIRE, BARE             |            |             |
| 34  | 3085        | WIRE, BARE             |            |             |
| 35  | 3086        | WIRE, BARE             |            |             |
| 36  | 3087        | WIRE, BARE             |            |             |
| 37  | 3088        | WIRE, BARE             |            |             |
| 38  | 3089        | WIRE, BARE             |            |             |
| 39  | 3090        | WIRE, BARE             |            |             |
| 40  | 3091        | WIRE, BARE             |            |             |
| 41  | 3092        | WIRE, BARE             |            |             |
| 42  | 3093        | WIRE, BARE             |            |             |
| 43  | 3094        | WIRE, BARE             |            |             |
| 44  | 3095        | WIRE, BARE             |            |             |
| 45  | 3096        | WIRE, BARE             |            |             |
| 46  | 3097        | WIRE, BARE             |            |             |
| 47  | 3098        | WIRE, BARE             |            |             |
| 48  | 3099        | WIRE, BARE             |            |             |
| 49  | 3100        | WIRE, BARE             |            |             |
| 50  | 3101        | WIRE, BARE             |            |             |
| 51  | 3102        | WIRE, BARE             |            |             |
| 52  | 3103        | WIRE, BARE             |            |             |
| 53  | 3104        | WIRE, BARE             |            |             |
| 54  | 3105        | WIRE, BARE             |            |             |
| 55  | 3106        | WIRE, BARE             |            |             |
| 56  | 3107        | WIRE, BARE             |            |             |
| 57  | 3108        | WIRE, BARE             |            |             |
| 58  | 3109        | WIRE, BARE             |            |             |
| 59  | 3110        | WIRE, BARE             |            |             |
| 60  | 3111        | WIRE, BARE             |            |             |
| 61  | 3112        | WIRE, BARE             |            |             |
| 62  | 3113        | WIRE, BARE             |            |             |
| 63  | 3114        | WIRE, BARE             |            |             |
| 64  | 3115        | WIRE, BARE             |            |             |
| 65  | 3116        | WIRE, BARE             |            |             |
| 66  | 3117        | WIRE, BARE             |            |             |
| 67  | 3118        | WIRE, BARE             |            |             |
| 68  | 3119        | WIRE, BARE             |            |             |
| 69  | 3120        | WIRE, BARE             |            |             |
| 70  | 3121        | WIRE, BARE             |            |             |
| 71  | 3122        | WIRE, BARE             |            |             |
| 72  | 3123        | WIRE, BARE             |            |             |
| 73  | 3124        | WIRE, BARE             |            |             |
| 74  | 3125        | WIRE, BARE             |            |             |
| 75  | 3126        | WIRE, BARE             |            |             |
| 76  | 3127        | WIRE, BARE             |            |             |
| 77  | 3128        | WIRE, BARE             |            |             |
| 78  | 3129        | WIRE, BARE             |            |             |
| 79  | 3130        | WIRE, BARE             |            |             |
| 80  | 3131        | WIRE, BARE             |            |             |
| 81  | 3132        | WIRE, BARE             |            |             |
| 82  | 3133        | WIRE, BARE             |            |             |
| 83  | 3134        | WIRE, BARE             |            |             |
| 84  | 3135        | WIRE, BARE             |            |             |
| 85  | 3136        | WIRE, BARE             |            |             |
| 86  | 3137        | WIRE, BARE             |            |             |
| 87  | 3138        | WIRE, BARE             |            |             |
| 88  | 3139        | WIRE, BARE             |            |             |
| 89  | 3140        | WIRE, BARE             |            |             |
| 90  | 3141        | WIRE, BARE             |            |             |
| 91  | 3142        | WIRE, BARE             |            |             |
| 92  | 3143        | WIRE, BARE             |            |             |
| 93  | 3144        | WIRE, BARE             |            |             |
| 94  | 3145        | WIRE, BARE             |            |             |
| 95  | 3146        | WIRE, BARE             |            |             |
| 96  | 3147        | WIRE, BARE             |            |             |
| 97  | 3148        | WIRE, BARE             |            |             |
| 98  | 3149        | WIRE, BARE             |            |             |
| 99  | 3150        | WIRE, BARE             |            |             |
| 100 | 3151        | WIRE, BARE             |            |             |

| QTY | PART NUMBER | DESCRIPTION            | UNIT PRICE | TOTAL PRICE |
|-----|-------------|------------------------|------------|-------------|
| 1   | 3152        | SHRINK TUBE (2' LONG)  |            |             |
| 2   | 3153        | BRAID                  |            |             |
| 3   | 3154        | FRONT PANEL CABLE ASSY |            |             |
| 4   | 3155        | WIRE, ROUND            |            |             |
| 5   | 3156        | WIRE, BARE             |            |             |
| 6   | 3157        | WIRE, BARE             |            |             |
| 7   | 3158        | WIRE, BARE             |            |             |
| 8   | 3159        | WIRE, BARE             |            |             |
| 9   | 3160        | WIRE, BARE             |            |             |
| 10  | 3161        | WIRE, BARE             |            |             |
| 11  | 3162        | WIRE, BARE             |            |             |
| 12  | 3163        | WIRE, BARE             |            |             |
| 13  | 3164        | WIRE, BARE             |            |             |
| 14  | 3165        | WIRE, BARE             |            |             |
| 15  | 3166        | WIRE, BARE             |            |             |
| 16  | 3167        | WIRE, BARE             |            |             |
| 17  | 3168        | WIRE, BARE             |            |             |
| 18  | 3169        | WIRE, BARE             |            |             |
| 19  | 3170        | WIRE, BARE             |            |             |
| 20  | 3171        | WIRE, BARE             |            |             |
| 21  | 3172        | WIRE, BARE             |            |             |
| 22  | 3173        | WIRE, BARE             |            |             |
| 23  | 3174        | WIRE, BARE             |            |             |
| 24  | 3175        | WIRE, BARE             |            |             |
| 25  | 3176        | WIRE, BARE             |            |             |
| 26  | 3177        | WIRE, BARE             |            |             |
| 27  | 3178        | WIRE, BARE             |            |             |
| 28  | 3179        | WIRE, BARE             |            |             |
| 29  | 3180        | WIRE, BARE             |            |             |
| 30  | 3181        | WIRE, BARE             |            |             |
| 31  | 3182        | WIRE, BARE             |            |             |
| 32  | 3183        | WIRE, BARE             |            |             |
| 33  | 3184        | WIRE, BARE             |            |             |
| 34  | 3185        | WIRE, BARE             |            |             |
| 35  | 3186        | WIRE, BARE             |            |             |
| 36  | 3187        | WIRE, BARE             |            |             |
| 37  | 3188        | WIRE, BARE             |            |             |
| 38  | 3189        | WIRE, BARE             |            |             |
| 39  | 3190        | WIRE, BARE             |            |             |
| 40  | 3191        | WIRE, BARE             |            |             |
| 41  | 3192        | WIRE, BARE             |            |             |
| 42  | 3193        | WIRE, BARE             |            |             |
| 43  | 3194        | WIRE, BARE             |            |             |
| 44  | 3195        | WIRE, BARE             |            |             |
| 45  | 3196        | WIRE, BARE             |            |             |
| 46  | 3197        | WIRE, BARE             |            |             |
| 47  | 3198        | WIRE, BARE             |            |             |
| 48  | 3199        | WIRE, BARE             |            |             |
| 49  | 3200        | WIRE, BARE             |            |             |
| 50  | 3201        | WIRE, BARE             |            |             |
| 51  | 3202        | WIRE, BARE             |            |             |
| 52  | 3203        | WIRE, BARE             |            |             |
| 53  | 3204        | WIRE, BARE             |            |             |
| 54  | 3205        | WIRE, BARE             |            |             |
| 55  | 3206        | WIRE, BARE             |            |             |
| 56  | 3207        | WIRE, BARE             |            |             |
| 57  | 3208        | WIRE, BARE             |            |             |
| 58  | 3209        | WIRE, BARE             |            |             |
| 59  | 3210        | WIRE, BARE             |            |             |
| 60  | 3211        | WIRE, BARE             |            |             |
| 61  | 3212        | WIRE, BARE             |            |             |
| 62  | 3213        | WIRE, BARE             |            |             |
| 63  | 3214        | WIRE, BARE             |            |             |
| 64  | 3215        | WIRE, BARE             |            |             |
| 65  | 3216        | WIRE, BARE             |            |             |
| 66  | 3217        | WIRE, BARE             |            |             |
| 67  | 3218        | WIRE, BARE             |            |             |
| 68  | 3219        | WIRE, BARE             |            |             |
| 69  | 3220        | WIRE, BARE             |            |             |
| 70  | 3221        | WIRE, BARE             |            |             |
| 71  | 3222        | WIRE, BARE             |            |             |
| 72  | 3223        | WIRE, BARE             |            |             |
| 73  | 3224        | WIRE, BARE             |            |             |
| 74  | 3225        | WIRE, BARE             |            |             |
| 75  | 3226        | WIRE, BARE             |            |             |
| 76  | 3227        | WIRE, BARE             |            |             |
| 77  | 3228        | WIRE, BARE             |            |             |
| 78  | 3229        | WIRE, BARE             |            |             |
| 79  | 3230        | WIRE, BARE             |            |             |
| 80  | 3231        | WIRE, BARE             |            |             |
| 81  | 3232        | WIRE, BARE             |            |             |
| 82  | 3233        | WIRE, BARE             |            |             |
| 83  | 3234        | WIRE, BARE             |            |             |
| 84  | 3235        | WIRE, BARE             |            |             |
| 85  | 3236        | WIRE, BARE             |            |             |
| 86  | 3237        | WIRE, BARE             |            |             |
| 87  | 3238        | WIRE, BARE             |            |             |
| 88  | 3239        | WIRE, BARE             |            |             |
| 89  | 3240        | WIRE, BARE             |            |             |
| 90  | 3241        | WIRE, BARE             |            |             |
| 91  | 3242        | WIRE, BARE             |            |             |
| 92  | 3243        | WIRE, BARE             |            |             |
| 93  | 3244        | WIRE, BARE             |            |             |
| 94  | 3245        | WIRE, BARE             |            |             |
| 95  | 3246        | WIRE, BARE             |            |             |
| 96  | 3247        | WIRE, BARE             |            |             |
| 97  | 3248        | WIRE, BARE             |            |             |
| 98  | 3249        | WIRE, BARE             |            |             |
| 99  | 3250        | WIRE, BARE             |            |             |
| 100 | 3251        | WIRE, BARE             |            |             |

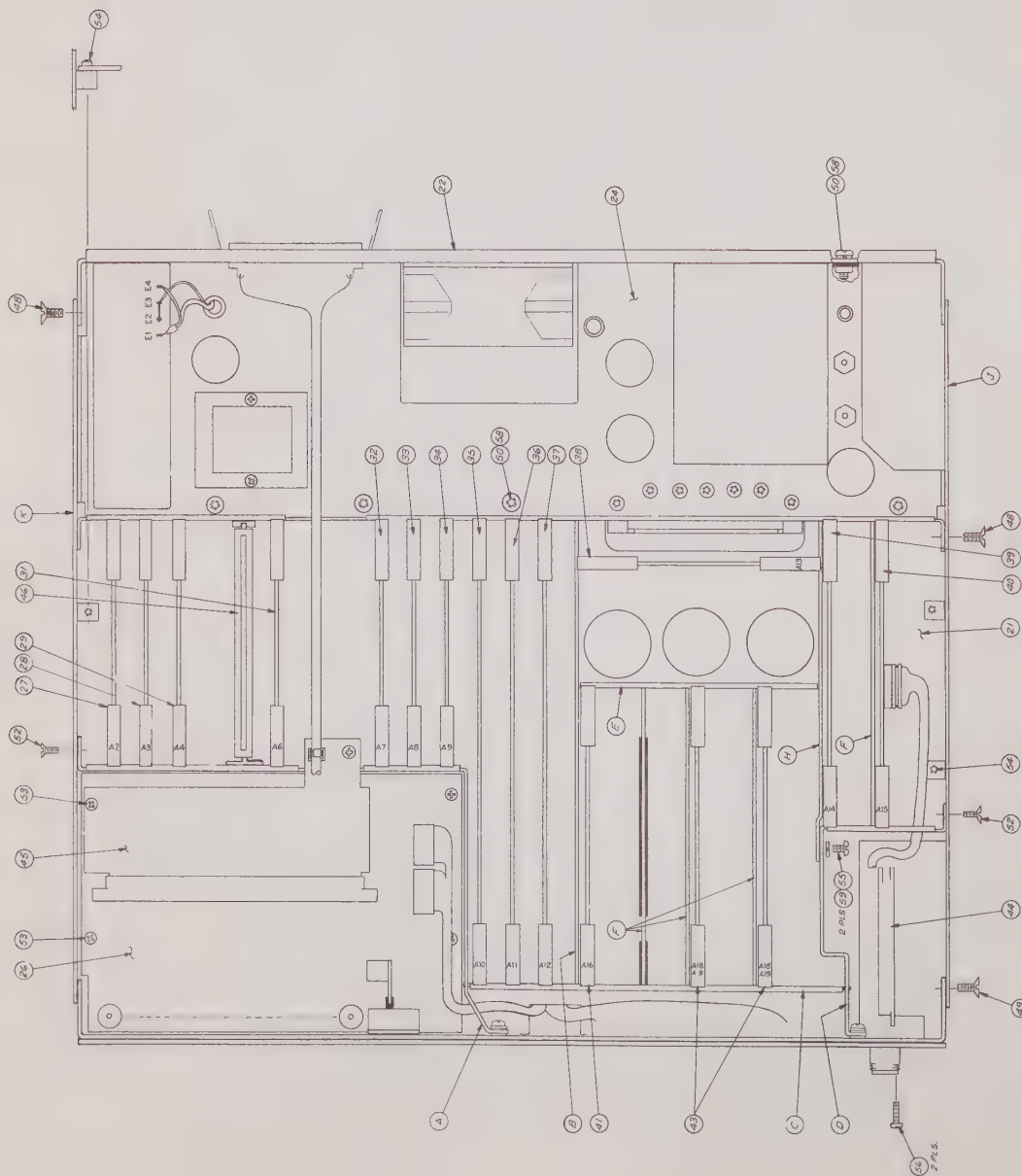


1) \* - DENOTES 20 GA. BARE WIRE W/TEFLON SLEEVE (2 PLACES)

REAR PANEL ASSEMBLY #D39187D



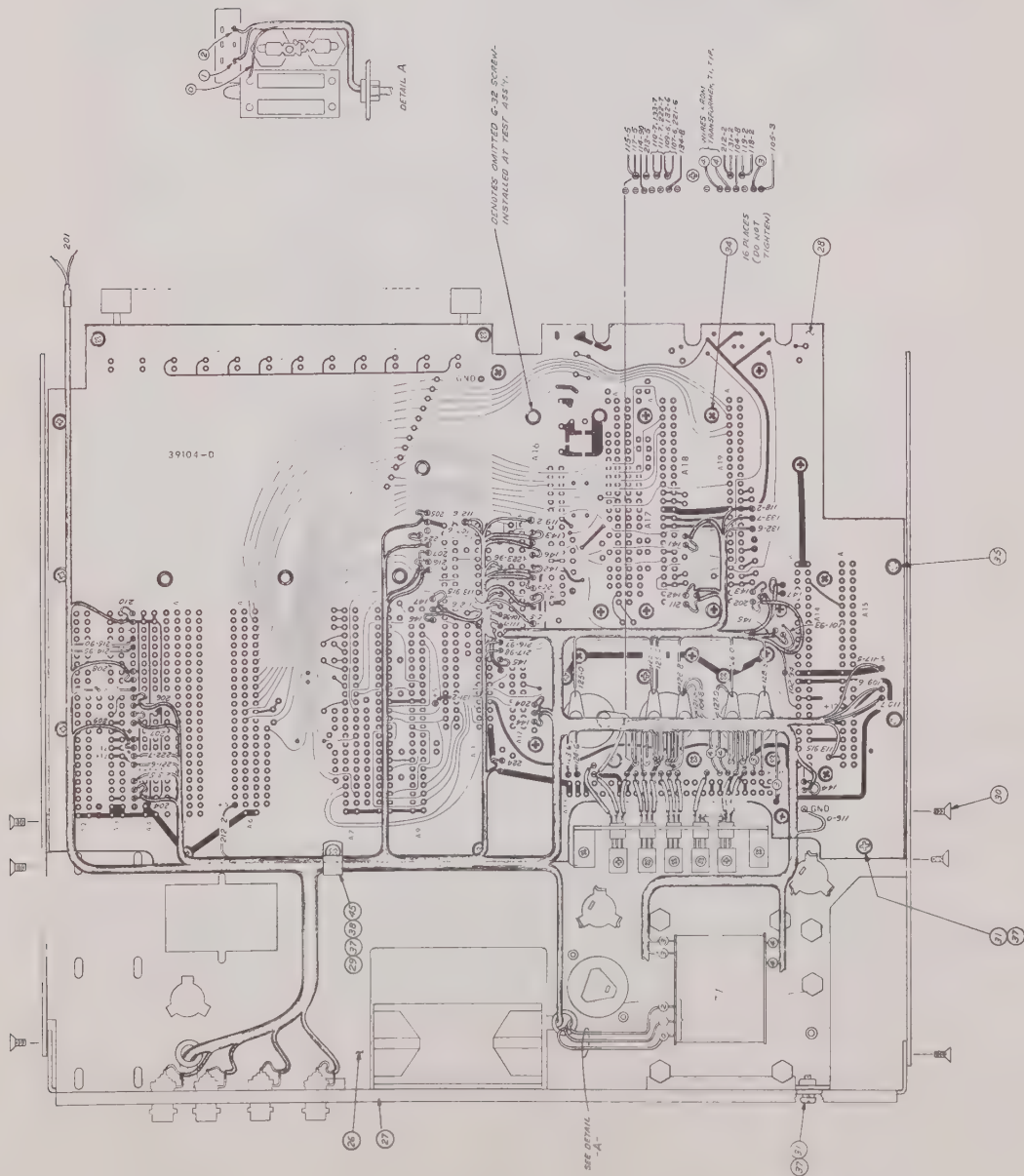
|      |    |                       |                               |
|------|----|-----------------------|-------------------------------|
| 20.1 | 4  | H1476                 | WASHER, NR 4 FLAT NYLON       |
| 20   | 4  | 62003670              | WASHER, NR 6 FLAT             |
| 19   | 4  | H 0410                | WASHER, NR 6 INTERNAL TOOTH   |
| 18   | 4  | N 0986                | SCREW, 6-32 X 1/4 PHNS        |
| 17   | 4  | ADHESIVE, EASTMAN 810 |                               |
| 16   | 4  | H-1829                | CHIPPILLER STRIP              |
| 15   | 36 | H-1861                | RHET, 0.08 DIA. X 1/48 LONG   |
| 14   | 1  | H-1886                | PC GUIDE (BIRCHER CLIP)       |
| 13   | 2  | A39567                | PC GUIDE, NYLON, MODIFIED     |
| 12   | 18 | 421340-1-1            | PC GUIDE, NYLON               |
| 11   | 9  | E-0117                | SMALL NUT, RIGHT ANGLE, 6-32  |
| 10   | 16 | 60139120              | RIGHT ANGLE PLATING NUT, 6-32 |
| 9    | 1  | C39437                | GUSSET, RIGHT                 |
| 8    | 1  | C39436                | GUSSET, LEFT                  |
| 7    | 1  | B29388                | SIZE SUPPORT                  |
| 6    | 4  | B29390                | CAGE, RUNNER                  |
| 5    | 1  | B29389                | CAGE, CENTER PLATE            |
| 4    | 1  | B29387                | CAGE, RIGHT PLATE             |
| 3    | 1  | C39386                | CAGE, LEFT PLATE              |
| 2    | 1  | C39385                | CAGE, CENTER DIVIDER          |
| 1    | 1  | C39384                | CAGE, LEFT SIDE               |
|      |    |                       | ASSEMBLY                      |
|      |    |                       | NO. 100                       |



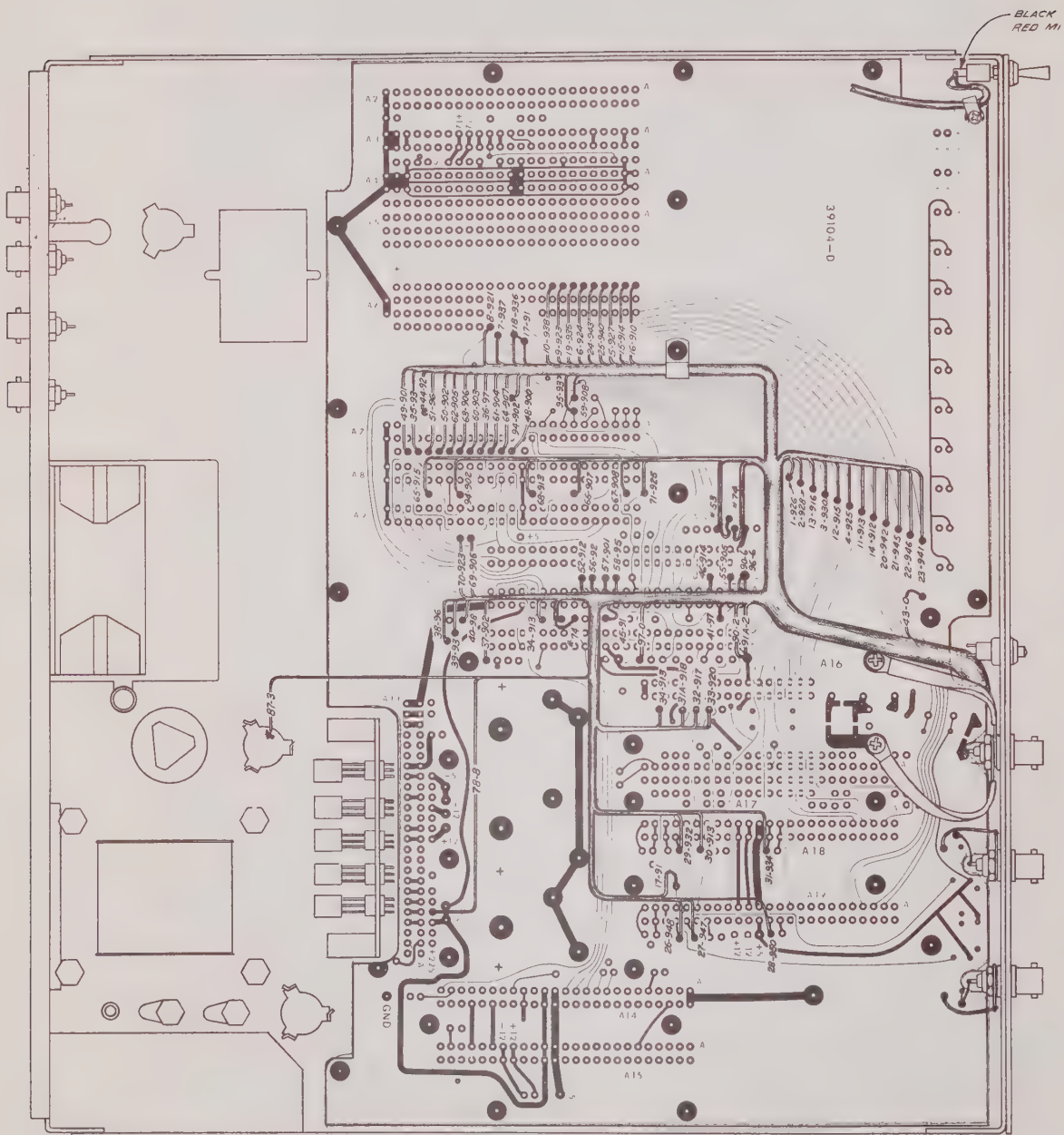
| QTY | REV | PART NUMBER | DESCRIPTION                                         | REMARKS  |
|-----|-----|-------------|-----------------------------------------------------|----------|
| 59  | 2B  | H-0783      | WASHER, #6, SPLIT-LOCK                              |          |
| 58  | 4   | H-0784      | WASHER, #8 SPLIT-LOCK                               |          |
| 57  |     |             |                                                     |          |
| 56  | 2   | H-0376      | SCREW, 4-40 x 1/2 PHMS                              |          |
| 55  | 2   | H-0386      | SCREW, 6-32 x 1/2 PHMS                              |          |
| 54  | 5   | H-0551      | SCREW, 6-32 x 1/2 FILLISTER HWS                     |          |
| 53  | 2B  | H-0989      | SCREW, 6-32 x 1/2 PHMS (22 THRU MB AND FRONTING MB) |          |
| 52  | 4   | H-0430      | SCREW, 6-32 x 1/2 PHMS                              |          |
| 51  |     |             |                                                     |          |
| 50  | 8   | H-0987      | SCREW, 8-32 x 1/2 PHMS                              |          |
| 49  | 6   | H-1756      | SCREW, 8-32 x 1/2 PHMS                              |          |
| 48  | 13  | H-0679      | SCREW, 8-32 x 1/2 PHMS                              |          |
| 47  |     |             |                                                     |          |
| 46  | 1   | B-39159     | EXTENDER PC ASSY                                    |          |
| 45  | 1   | B-39379     | BCD OUTPUT PC ASSY                                  | A21      |
| 44  | 1   | B-39684     | WIRE CABLE ASSY                                     | A30      |
| 43  | 2   | B-39351     | 10 MHZ AMP PC ASSY                                  | A18, A19 |
| 42  |     |             |                                                     |          |
| 41  | 1   | B-39329     | 200 MHZ AMP PC ASSY                                 | A16      |
| 40  | 1   | C-39371     | SHIFTER PC ASSY                                     | A15      |
| 39  | 1   | B-39375     | N COMPUTER PC ASSY                                  | A14      |
| 38  | 1   | B-39351     | MAIN POWER PC ASSY                                  | A13      |
| 37  | 1   | C-39327     | 200 MHZ DECODE & GATE PC ASSY                       | A12      |
| 36  | 1   | C-39343     | FUNCTION CONTROL PC ASSY                            | A11      |
| 35  | 1   | C-39347     | TIME BASE PC ASSY                                   | A10      |
| 34  | 1   | C-39339     | DECIMAL LOGIC PC ASSY                               | A9       |
| 33  | 1   | B-39335     | LEGEND LOGIC PC ASSY                                | A8       |
| 32  | 1   | B-39603     | FUNCTION SELECT PC ASSY                             | A7       |
| 31  | 1   | B-39355     | ATTEN. SELECT PC ASSY                               | A6       |
| 30  |     |             |                                                     |          |
| 29  | 1   | B-39363     | 100 MHZ MULT. PC ASSY                               | A4       |
| 28  | 1   | B-39359     | 10 MHZ OSC PC ASSY                                  | A3       |
| 27  | 1   | B-39367     | 3 MHZ OSC POWER PC ASSY                             | A2       |
| 26  | 1   | C-39363     | READOUT PC ASSY                                     | A1       |
| 25  |     |             |                                                     |          |
| 24  | 1   | D-39189     | POWER SUPPLY CHASSIS ASSY                           |          |
| 23  | 1   | D-39188     | FRONT PANEL ASSY                                    |          |
| 22  | 1   | D-39187     | REAR PANEL ASSY                                     |          |
| 21  | 1   | C-39114     | MOTHER BD. PC ASSY                                  |          |
| 20  |     |             |                                                     |          |
| 19  |     |             |                                                     |          |
| 18  |     |             |                                                     |          |
| 17  |     |             |                                                     |          |
| 16  |     |             |                                                     |          |
| 15  |     |             |                                                     |          |
| 14  |     |             |                                                     |          |
| 13  |     |             |                                                     |          |
| 12  |     |             |                                                     |          |
| 11  |     |             |                                                     |          |
| 10  |     |             |                                                     |          |
| 9   |     |             |                                                     |          |
| 8   |     |             |                                                     |          |
| 7   |     |             |                                                     |          |
| 6   |     |             |                                                     |          |
| 5   |     |             |                                                     |          |
| 4   |     |             |                                                     |          |
| 3   |     |             |                                                     |          |
| 2   |     |             |                                                     |          |
| 1   |     |             |                                                     |          |



# VIKING LABORATORIES INC.



| QTY | UNIT | DESCRIPTION       | REMARKS                          |
|-----|------|-------------------|----------------------------------|
| 45  | 1    | M-7290            |                                  |
| 44  |      | CABLE CLAMP, 3/8" |                                  |
| 43  |      |                   |                                  |
| 42  |      |                   |                                  |
| 41  |      |                   |                                  |
| 40  |      |                   |                                  |
| 39  | 2    | M-7183            | WASHER 3/8" FLAT                 |
| 38  | 1    | M-7160            | WASHER 3/8" FLAT                 |
| 37  | 8    | M-7064            | WASHER 3/8" FLAT                 |
| 36  |      |                   |                                  |
| 35  | 5    | M-6551            | SCREW, 6-32 X 1/2, MILLISTER NMS |
| 34  | 16   | M-7181            | SCREW, 6-32 X 1/2, NMS           |
| 33  |      |                   |                                  |
| 32  | 4    | M-7030            | SCREW, 6-32 X 1/2, NMS           |
| 31  | 4    | M-7087            | SCREW, 8-32 X 1/2, NMS           |
| 30  | 12   | M-6459            | SCREW, 8-32 X 1/2, NMS           |
| 29  | 1    | M-1448            | SCREW, 8-32 X 1/2, NMS           |
| 28  | 1    | C3B14             | MOTHER BOARD PC ASSY             |
| 27  | 1    | D3B157            | REAR PANEL ASSY                  |
| 26  | 1    |                   | POWER SUPPLY, 2-1500-5, 450W     |



UNIVERSAL CHASSIS/CABLE ASSEMBLY #D39895 (SHEET 2 OF 2)

## FRONT PANEL CABLE ASSEMBLY

| NO. | COLOR | FROM   | TO    | NO. | COLOR | FROM   | TO      | NO. | COLOR | FROM  | TO     |
|-----|-------|--------|-------|-----|-------|--------|---------|-----|-------|-------|--------|
| 17  | 91    | A19-Z  | A6-13 | 66  | 907   | P17-13 | A8-7    | 20  | 942   | S14-8 | A6-4   |
| 94  | 902   | A8-18  | A7-N  | 55  | 905   | P17-14 | A11-E   | 22  | 946   | S14-1 | A6-1   |
| 34  | 913   | A16-24 | A11-X | 90  | 6     | P16-1  | A11-A   | 26  | 948   | R3-1  | A19-22 |
| 51  | 96    | A7-21  | S2-3  | 39  | 93    | P16-2  | A12-AA  | 21  | 945   | S14-3 | A6-3   |
| 36  | 97    | A7-16  | S2-2  | 38  | 96    | P16-3  | A12-25  | 28  | 950   | S7-3  | A19-13 |
| 64  | 907   | A7-14  | S2-13 | 40  | 98    | P16-4  | A12-BB  | 27  | 947   | R3-3  | A19-21 |
| 59  | 908   | A7-J   | S2-12 | 37  | 902   | P16-5  | A12-24  | 72  | 0     | R3-2  | R2-2   |
| 63  | 906   | A7-18  | S2-11 | 91  | 2     | P16-6  | A12-1   | 6   | 924   | S12-2 | A6-F   |
| 62  | 905   | A7-19  | S2-10 | 97  | 0     | P16-8  | A12-11  | 4   | 925   | S12-1 | A6-7   |
| 35  | 93    | A7-22  | S2-4  | 91A | 2     | P16-9  | A12-1   | 5   | 927   | S11-7 | A6-C   |
| 48  | 900   | A7-13  | S2-5  | 57  | 901   | P16-10 | A11-R   | 3   | 930   | S11-1 | A6-9   |
| 49  | 901   | A7-23  | S2-6  | 41  | 97    | P16-11 | A12-C   | 1   | 926   | S11-8 | A6-12  |
| 50  | 902   | A7-20  | S2-7  | 58  | 95    | P16-12 | A11-P   | 2   | 928   | S11-3 | A6-11  |
| 60  | 903   | A7-17  | S2-8  | 53  | ---   | P16-13 | A10-4   | 29  | 923   | R2-1  | A18-22 |
| 61  | 904   | A7-15  | S2-9  | --- | 0     | P16-7  | A10 GND | 31  | 934   | S6-3  | A18-13 |
| 96  | 6     | A11-A  | S4-1  | 56  | 92    | P16-14 | A11-5   | 30  | 913   | R2-3  | A18-21 |
| 52  | 912   | A11-T  | R11-1 | 42  | 0     | S3-2   | R1-2    | 73  | 0     | R2-2  | R1-2   |
| 95  | 93    | A7-H   | S17-2 | 43  | 0     | S3-2   | MB GL   | 16  | 910   | S10-2 | A6-A   |
| 44  | 92    | A7-Y   | S17-1 | 45  | 91    | S3-1   | A11-14  | 14  | 912   | S10-1 | A6-5   |
| 69  | 906   | P17-1  | A9-17 | 8   | 921   | S16-3  | A6-15   | 13  | 916   | S9-1  | A6-10  |
| 70  | 923   | P17-3  | A9-18 | 9   | 923   | S16-2  | A6-J    | 15  | 914   | S9-7  | A6-B   |
| 71  | 925   | P17-4  | A9-B  | 19  | 935   | S18-3  | A6-11   | 31A | 918   | R1-1  | A16-X  |
| 46  | 914   | P17-6  | A11-D | 18  | 936   | S18-2  | A6-13   | 12  | 915   | S9-3  | A6-8   |
| 87  | 3     | P17-7  | A13-C | 10  | 938   | S13-2  | A6-K    | 11  | 913   | S9-8  | A6-6   |
| 65  | 915   | P17-8  | A8-21 | 7   | 937   | S13-3  | A6-14   | 32  | 917   | R1-3  | A16-W  |
| 68  | 913   | P17-9  | A8-11 | 25  | 940   | S15-2  | A6-D    | 33  | 920   | S5-3  | A16-18 |
| 78  | 8     | P17-10 | A13-F | 23  | 941   | S15-1  | A6-2    | 74  | ---   | A12-U | A10-C  |
| 67  | 908   | P17-12 | A8-2  | 24  | 943   | S14-7  | A6-E    |     |       |       |        |

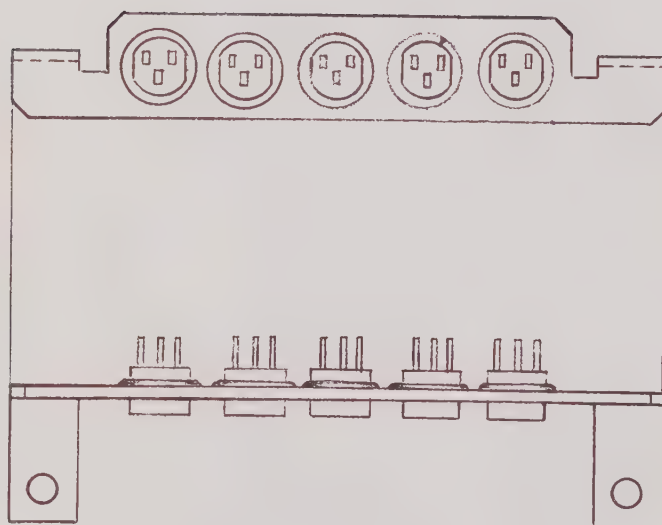
## REAR PANEL CABLE ASSEMBLY

| NO. | COLOR | FROM   | TO     | NO. | COLOR | FROM   | TO    | NO. | COLOR | FROM   | TO    |
|-----|-------|--------|--------|-----|-------|--------|-------|-----|-------|--------|-------|
| 201 | 2     | S21    | F1 TOP | 208 | ---   | A3-10  | J13   | 217 | 98    | A11-16 | S8-3  |
| 201 | 0     | S21    | S21-SW | 209 | ---   | A3-T   | J7    | 218 | 904   | T2-4   | L2-C8 |
| 201 | SHLD  | S21    | GL     | 210 | ---   | A3-B   | J8    | 219 | 903   | T2-3   | S21-4 |
| 202 | ---   | A19-CC | J9     | 211 | ---   | A18-CC | J10   | 220 | 901   | T2-1   | S21-6 |
| 203 | ---   | A12-H  | J5     | 212 | 2     | A13-E  | A6-BB | 221 | 6     | A13-N  | A3-V  |
| 204 | ---   | A12-Y  | A4-22  | 213 | 5     | A13-V  | A4-Y  | 222 | 7     | A13-S  | A3-U  |
| 205 | ---   | A10-3  | J6     | 214 | 95    | A3-E   | S20-1 | 223 | 96    | A11-6  | A3-P  |
| 206 | ---   | A10-F  | A3-12  | 215 | 90    | A3-C   | S20-3 | 224 | ---   | A12-CC | A10-4 |
| 207 | ---   | A10-6  | A3-R   | 216 | 97    | A11-15 | S23-1 |     |       |        |       |

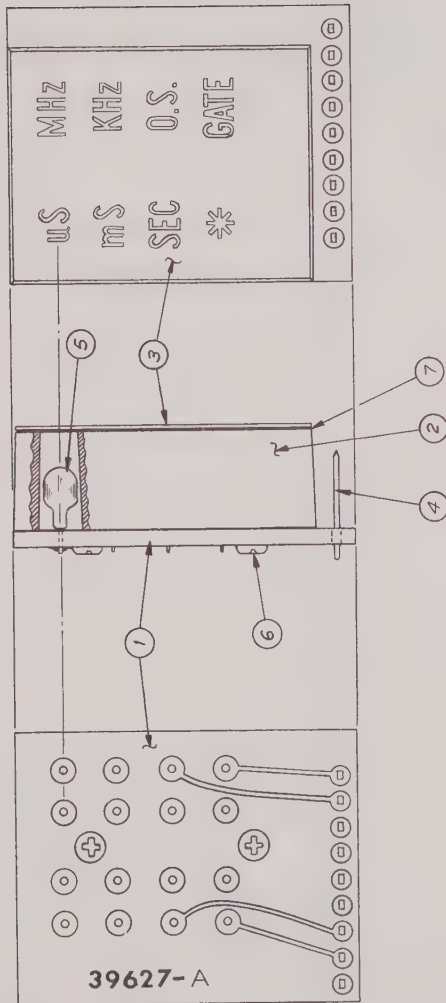
## POWER SUPPLY CABLE ASSEMBLY

| NO. | COLOR | FROM   | TO     | NO. | COLOR | FROM  | TO        | NO. | COLOR | FROM   | TO       |
|-----|-------|--------|--------|-----|-------|-------|-----------|-----|-------|--------|----------|
| 101 | 93    | A14-K  | A11-12 | 114 | 90    | C3 -  | A13-16&T  | 128 | 8     | C4 +   | C5 +     |
| 102 | 94    | A14-V  | A11-M  | 115 | 5     | A13-V | A12-14&R  | 131 | 2     | A13-E  | A10-22   |
| 103 | 0     | GL     | C1 -   | 116 | 0     | GL    | MB-GND    | 132 | 6     | A13-N  | A19-16   |
| 104 | 8     | C5 +   | A13-F  | 117 | 5     | A13-V | A15-14    | 133 | 7     | A13-S  | A19-15   |
| 105 | 3     | C1 +   | A13-C  | 118 | 2     | A13-E | A19-14    | 134 | 8     | C2 +   | A13-P&13 |
| 106 | 0     | C3 +   | C1 -   | 119 | 2     | A13-E | A12-1     | 141 | ---   | A12-K  | A18-W    |
| 107 | 6     | A13-N  | A11-A  | 121 | 8     | CR1&2 | C4 +      | 142 | ---   | A12-6  | A18-BB   |
| 109 | 6     | A13-N  | A15-18 | 123 | 6     | CR1   | A13-24&23 | 143 | ---   | A19-BB | A12-2    |
| 110 | 7     | A13-S  | A15-19 | 124 | 6     | CR2   | A13-24&BB | 144 | ---   | A12-20 | A14-BB   |
| 111 | 7     | A13-S  | A12-P  | 125 | 0     | C5 -  | C6 +      | 145 | ---   | A14-L  | A12-U    |
| 112 | 6     | A12-M  | A11-A  | 126 | 0     | C4 -  | C5 -      | 146 | ---   | A12-4  | A10-13   |
| 113 | 915   | A15-BB | A12-9  | 127 | 0     | GL    | C4 -      | 147 | ---   | A10-11 | A14-E    |

## WIRE LIST, UNIVERSAL CHASSIS/CABLE ASSEMBLIES



TRANSISTOR BRACKET ASSEMBLY #A39624A



| 10       |      |             |                                         |                    |  |
|----------|------|-------------|-----------------------------------------|--------------------|--|
| 9        |      |             |                                         |                    |  |
| 8        |      |             |                                         |                    |  |
| 7        | A/R  | H-1768      | PRESSURE SENSITIVE TAPE                 |                    |  |
| 6        | 2    | H-1271      | SCREW, NO 2 x 1/4, TYPE B, PHILLIPS HD. |                    |  |
| 5        | 8    | I-0101      | LAMP, INCANDESCENT (CM7220)             |                    |  |
| 4        | 7    | E-0322      | AMP-MODU POST STRIP, B6090-4            |                    |  |
| 3        | 1    | A 39440     | SPEC. ANNUNCIATOR LEGEND FILM           |                    |  |
| 2        | 1    | C 27873     | ANNUNCIATOR BLOCK                       |                    |  |
| 1        | 1    | B 39627     | ANNUNCIATOR P.C. BOARD                  |                    |  |
| ITEM NO. | QTY. | PART NUMBER | DESCRIPTION                             | SCHEMATIC REF. NO. |  |

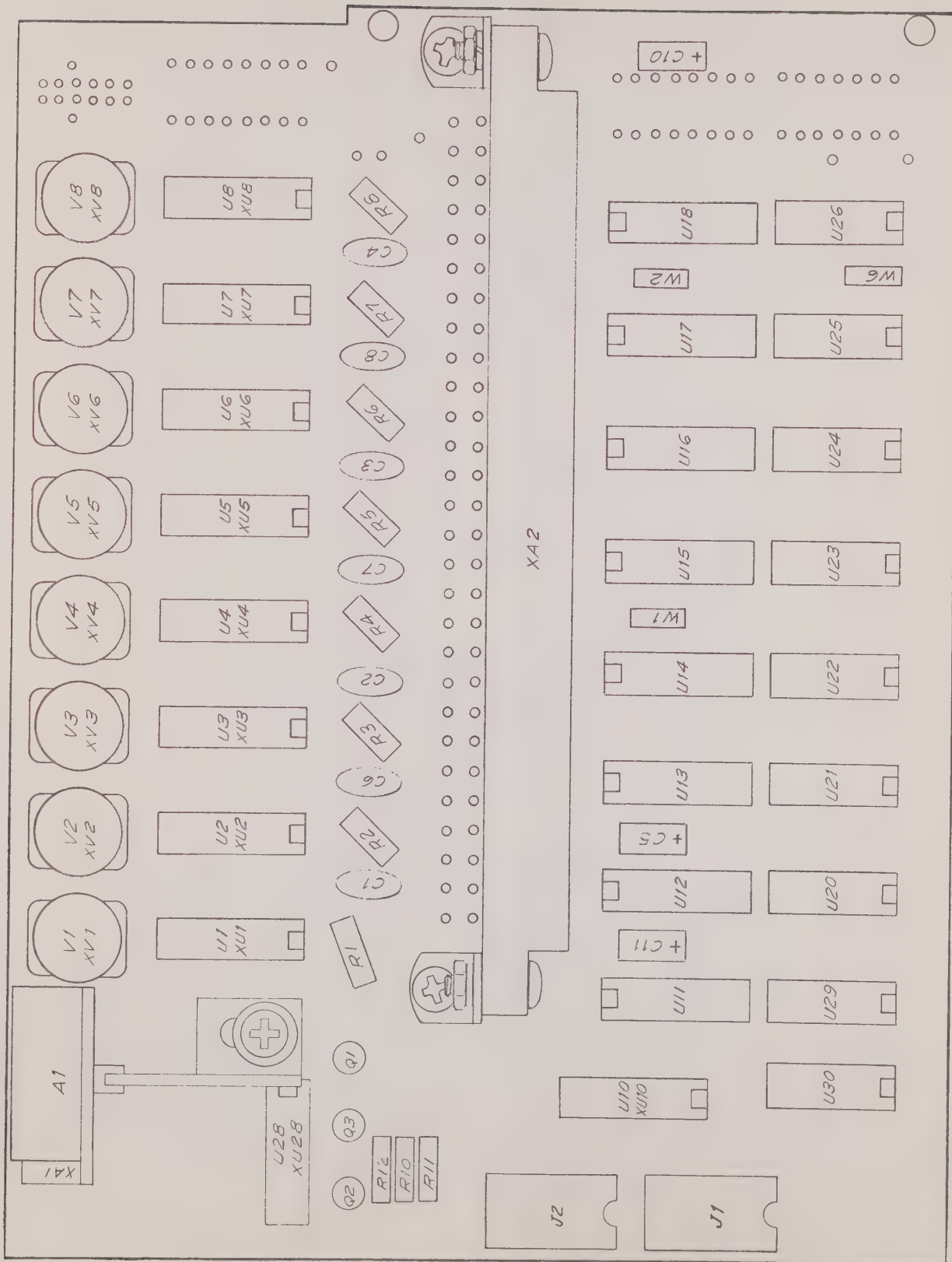
ANNUNCIATOR ASSEMBLY #C39186A



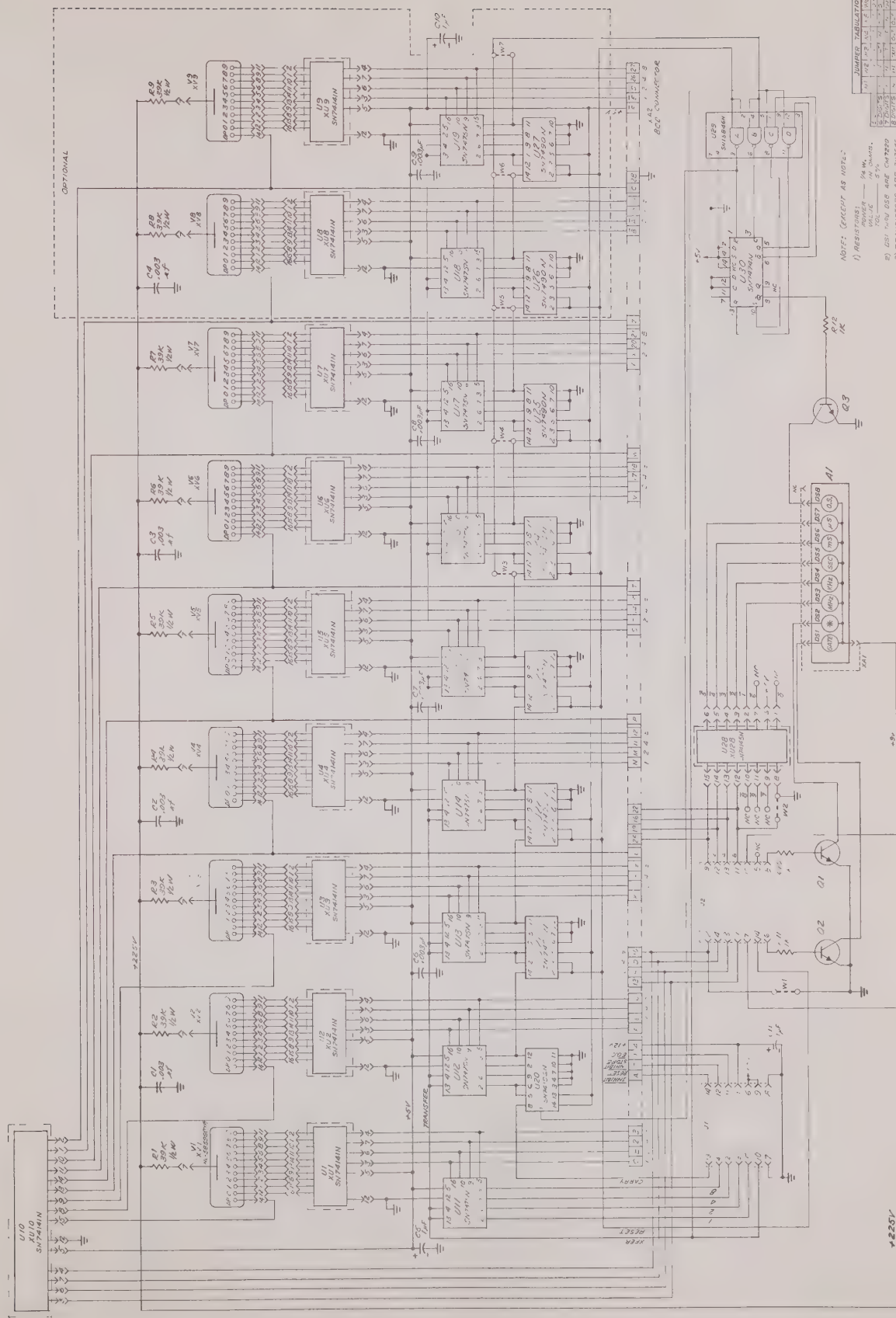


7-12

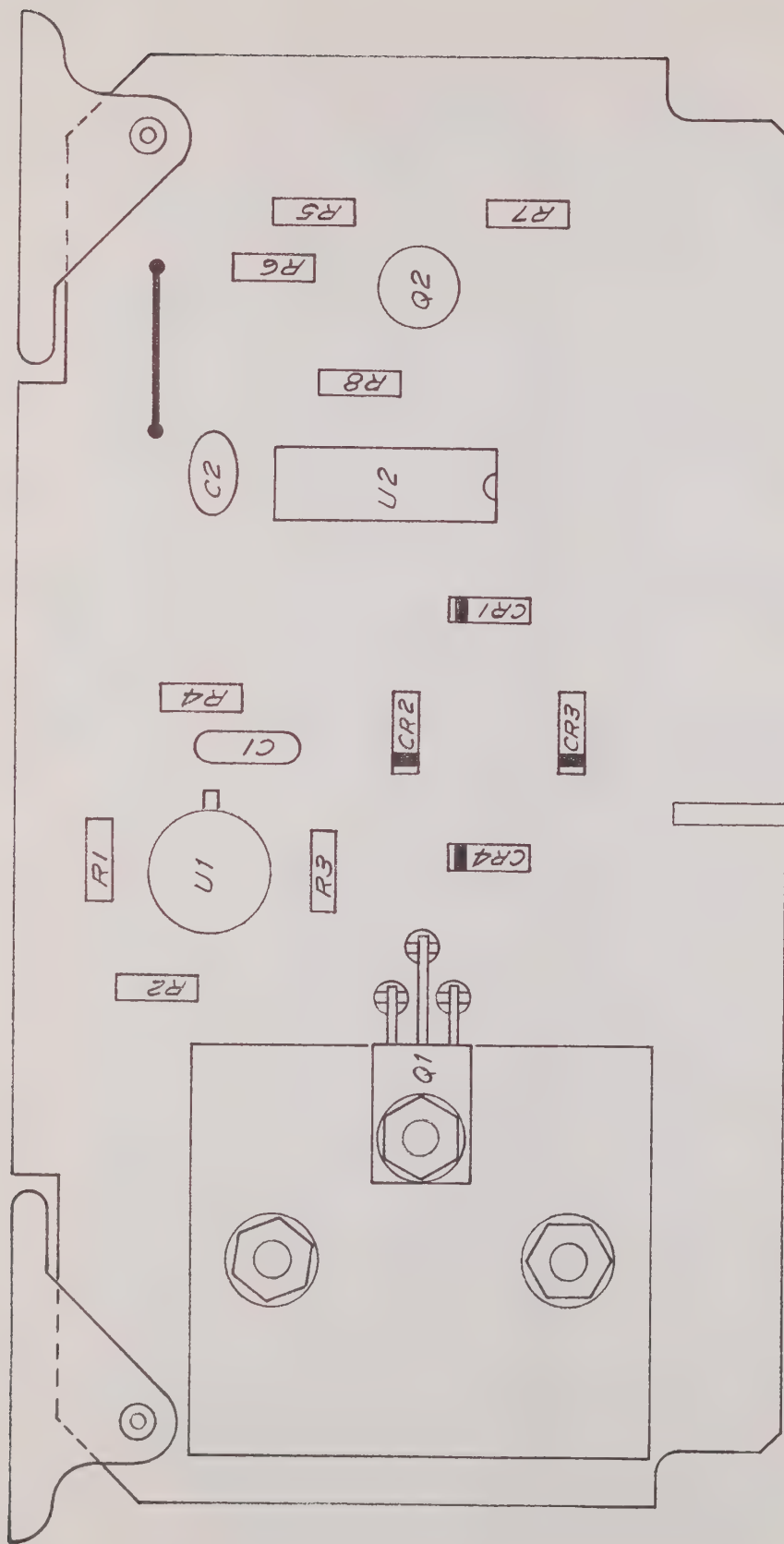




A1, READOUT P.C. ASSEMBLY #C39383D

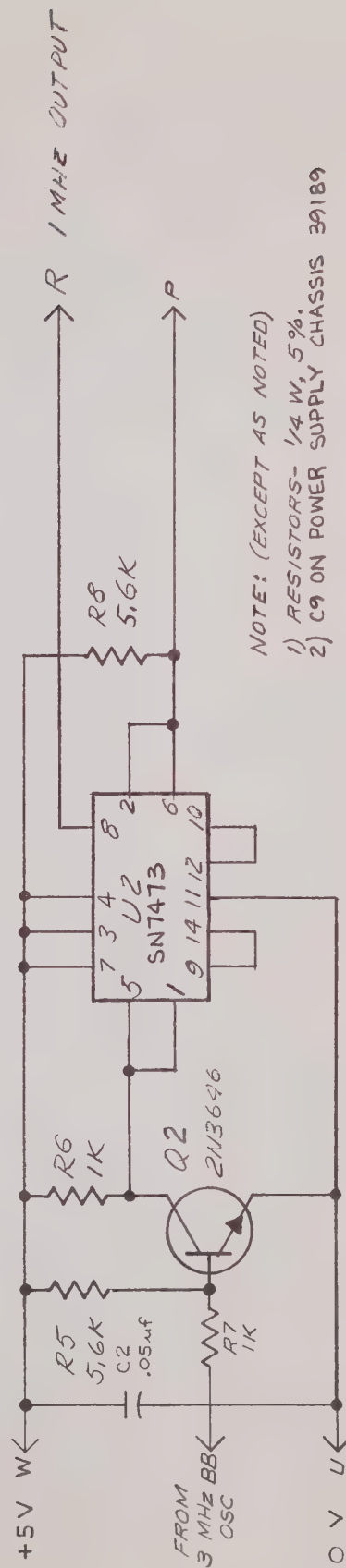
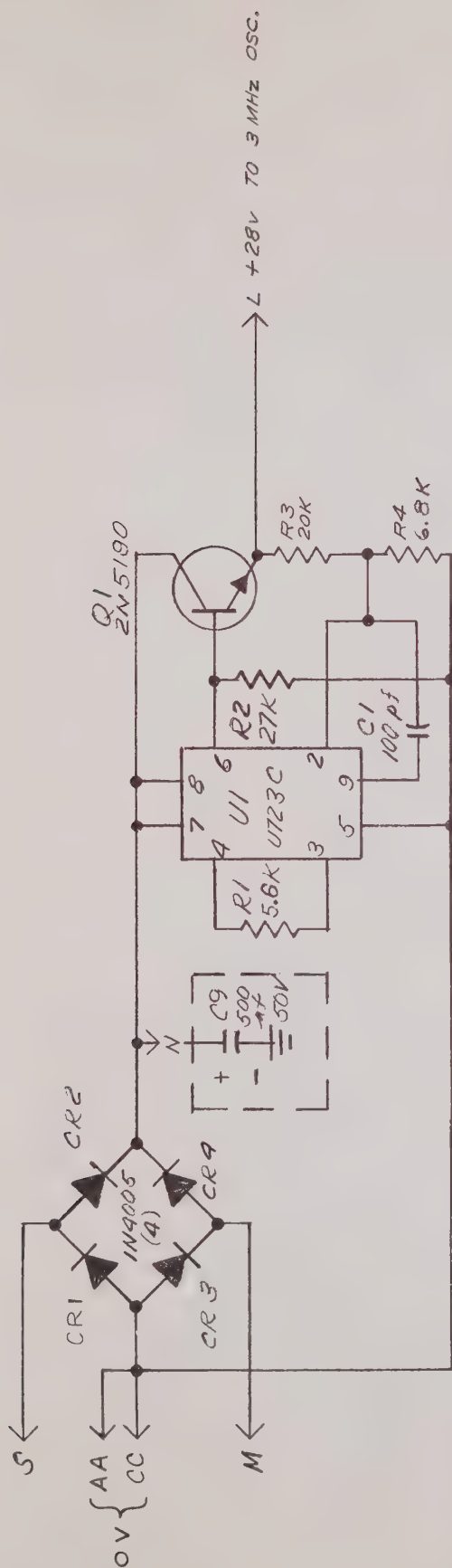


A1, READOUT SCHEMATIC #E39380D



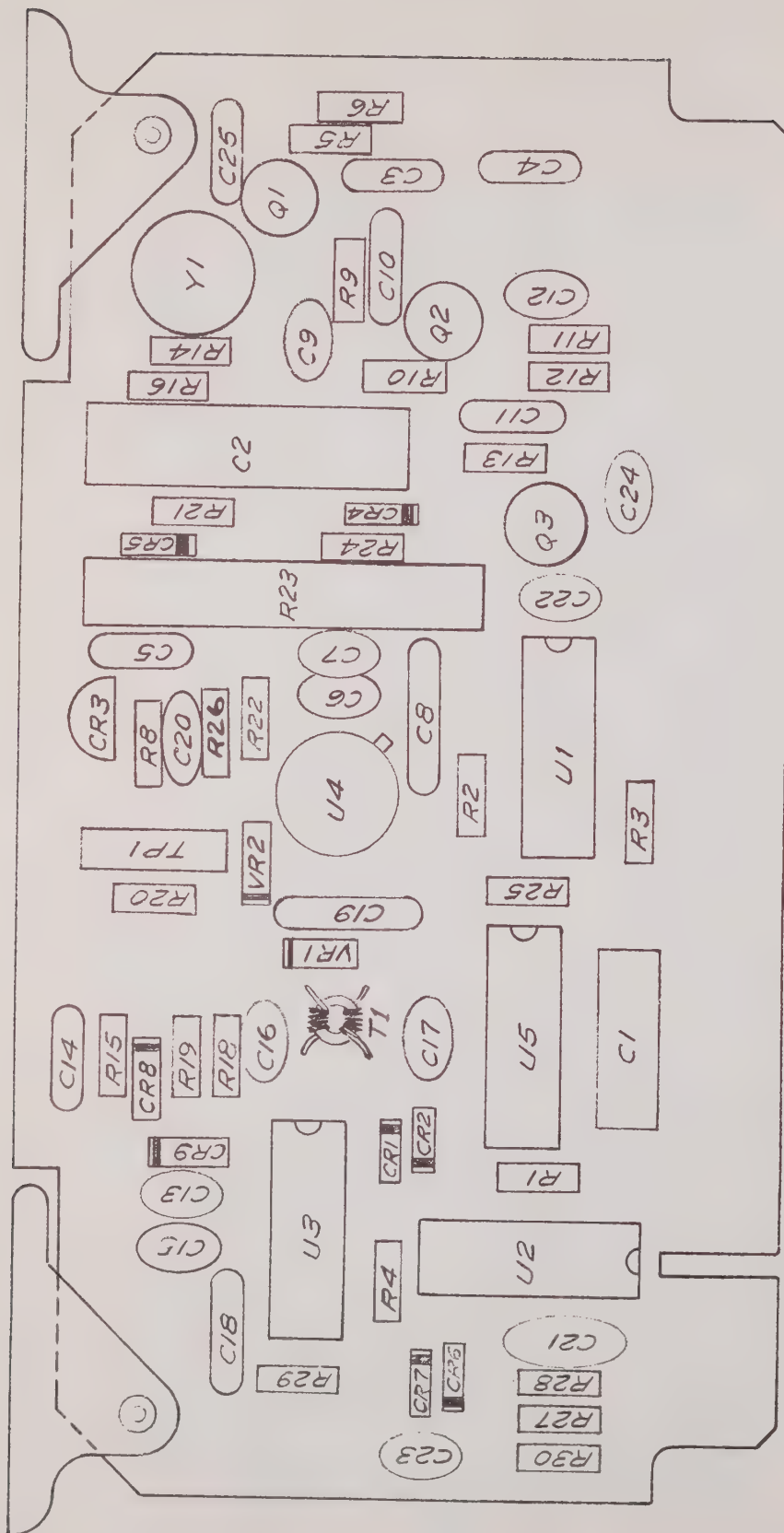
A2, 3 MHz OSCILLATOR POWER P.C. ASSEMBLY #B39367C



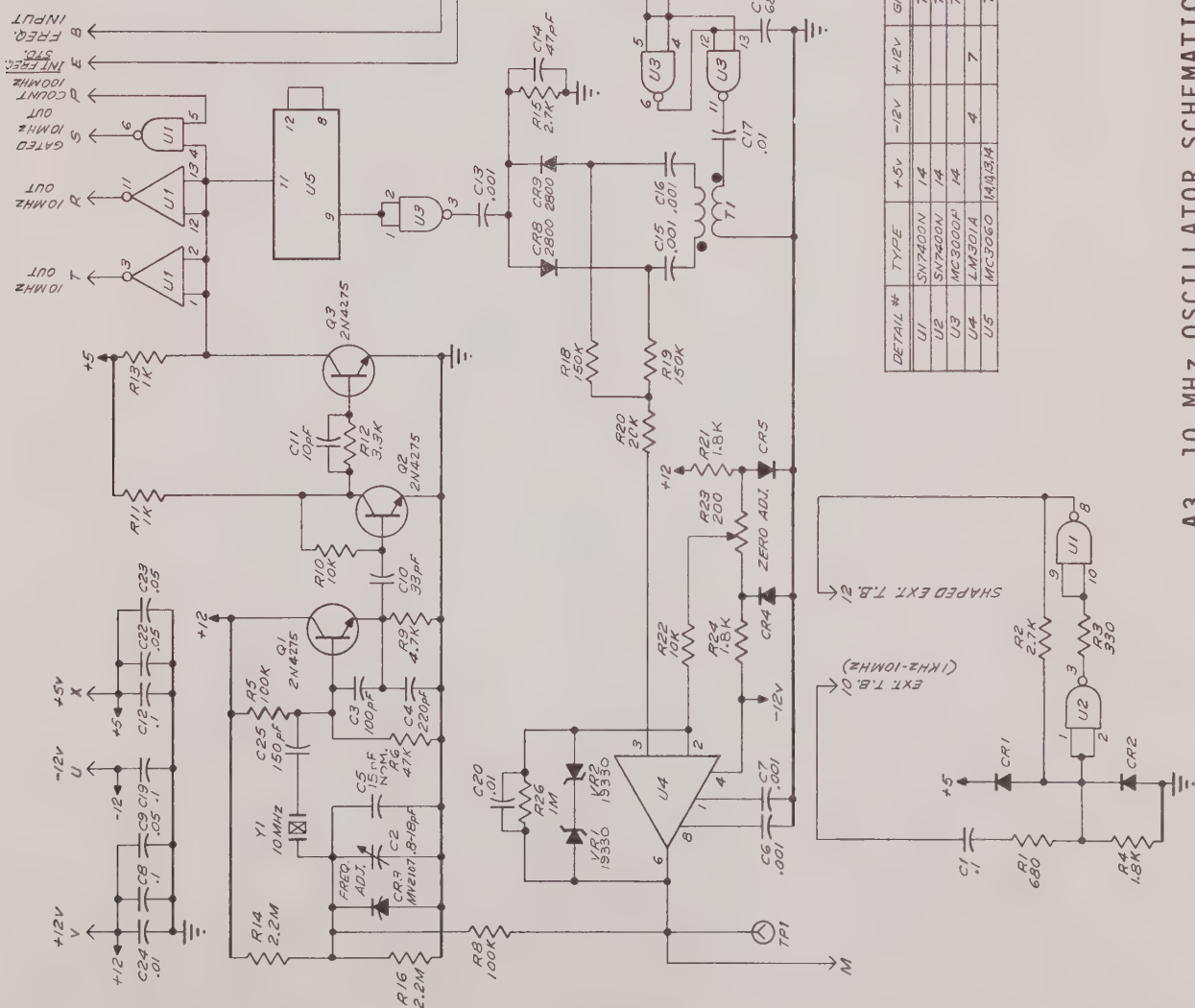


NOTE: (EXCEPT AS NOTED)

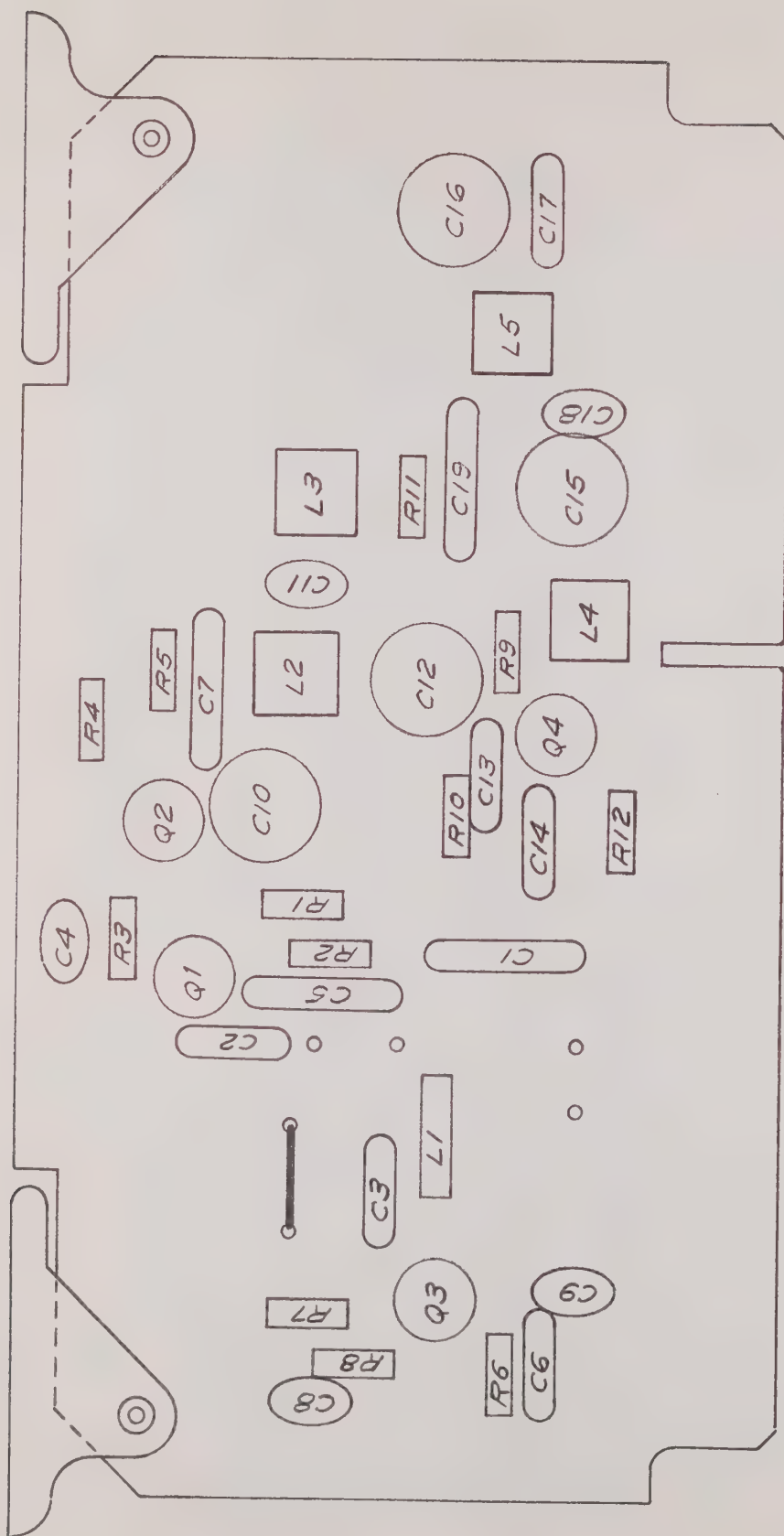
- 1) RESISTORS- 1/4 W, 5%.
- 2) C9 ON POWER SUPPLY CHASSIS 39189



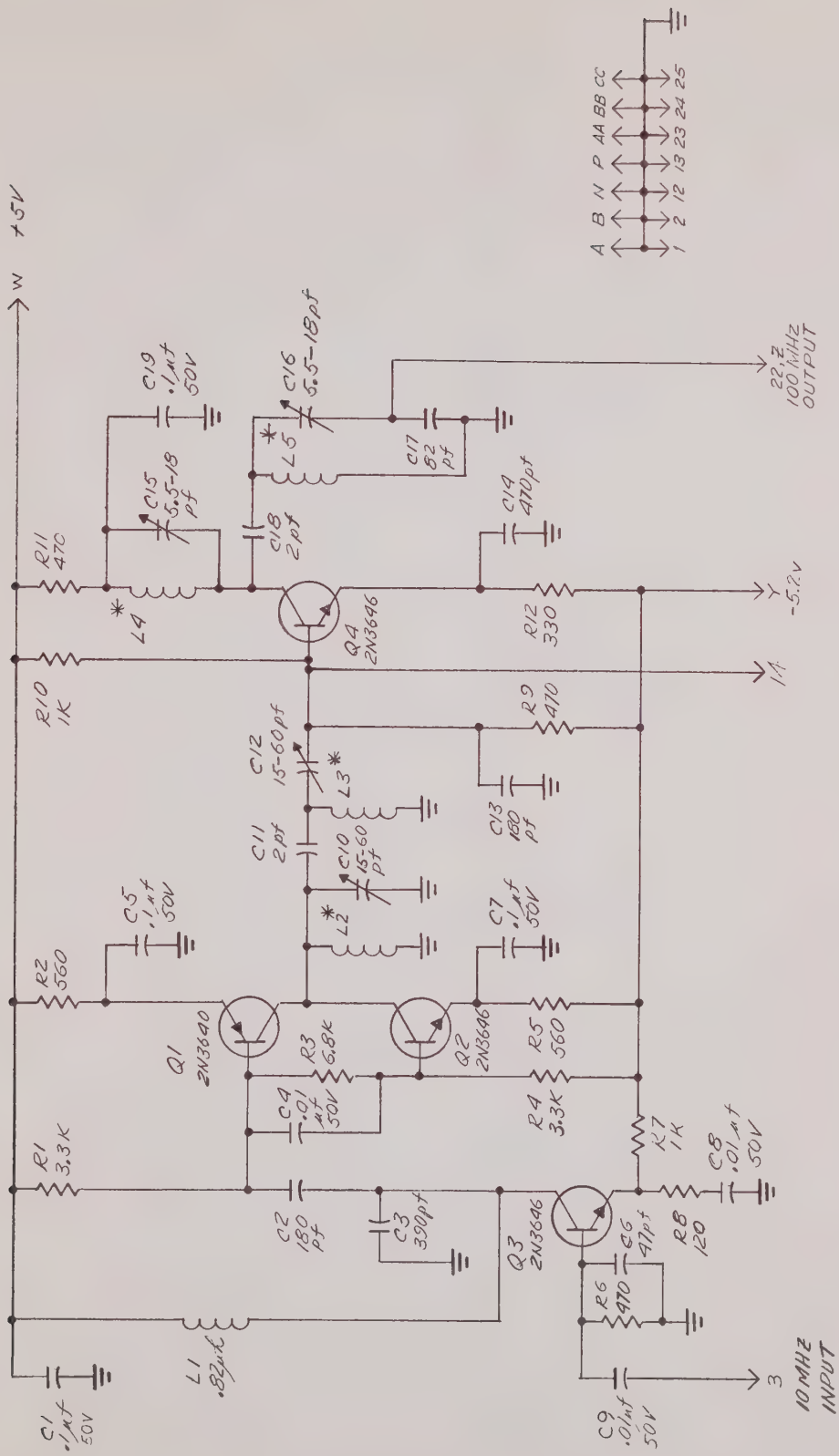
A3, 10 MHz OSCILLATOR P.C. ASSEMBLY #B39359G



A3, 10 MHz OSCILLATOR SCHEMATIC #C39356D



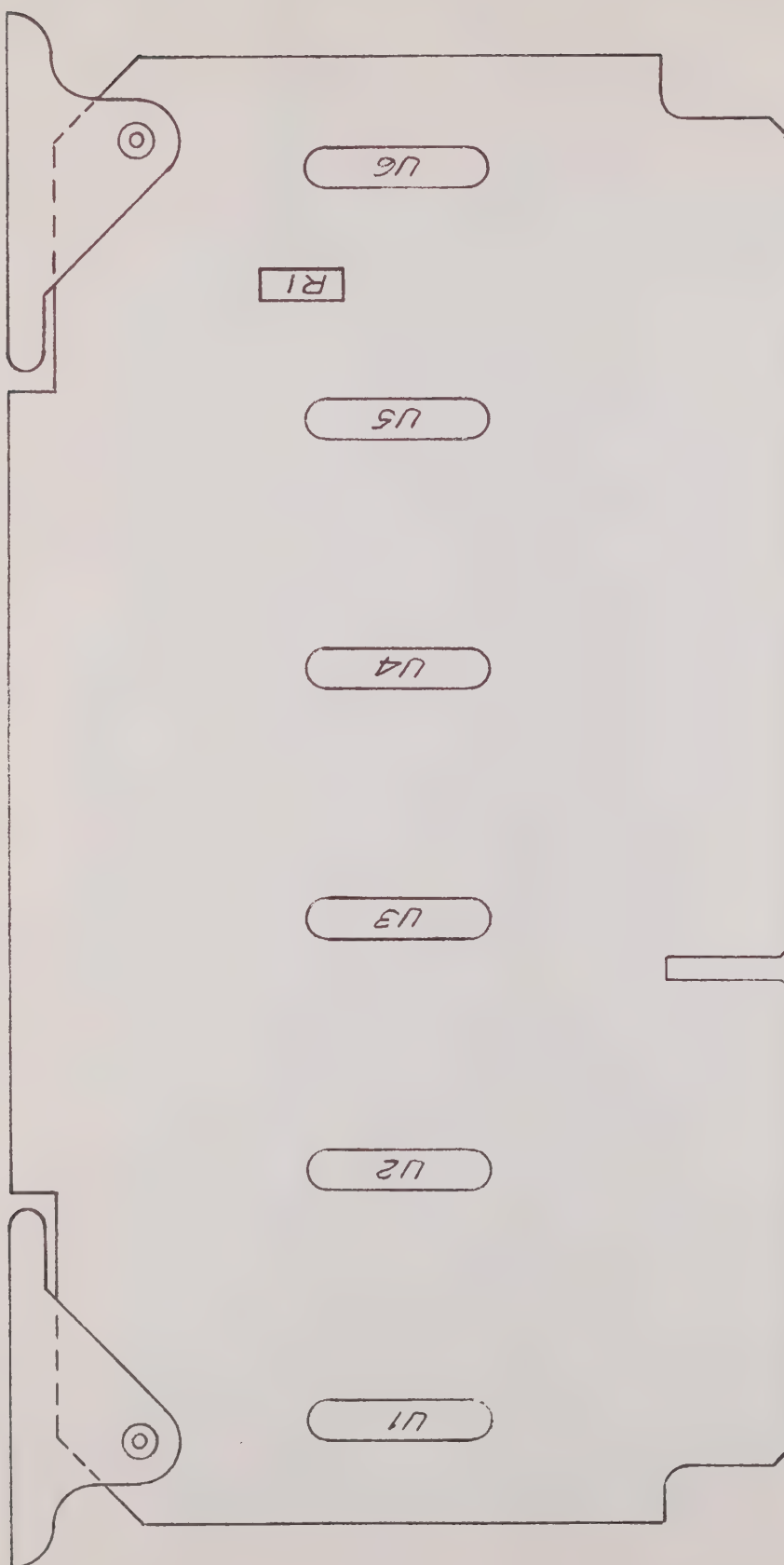
A4, 100 MHz MULTIPLIER P.C. ASSEMBLY #B39363A



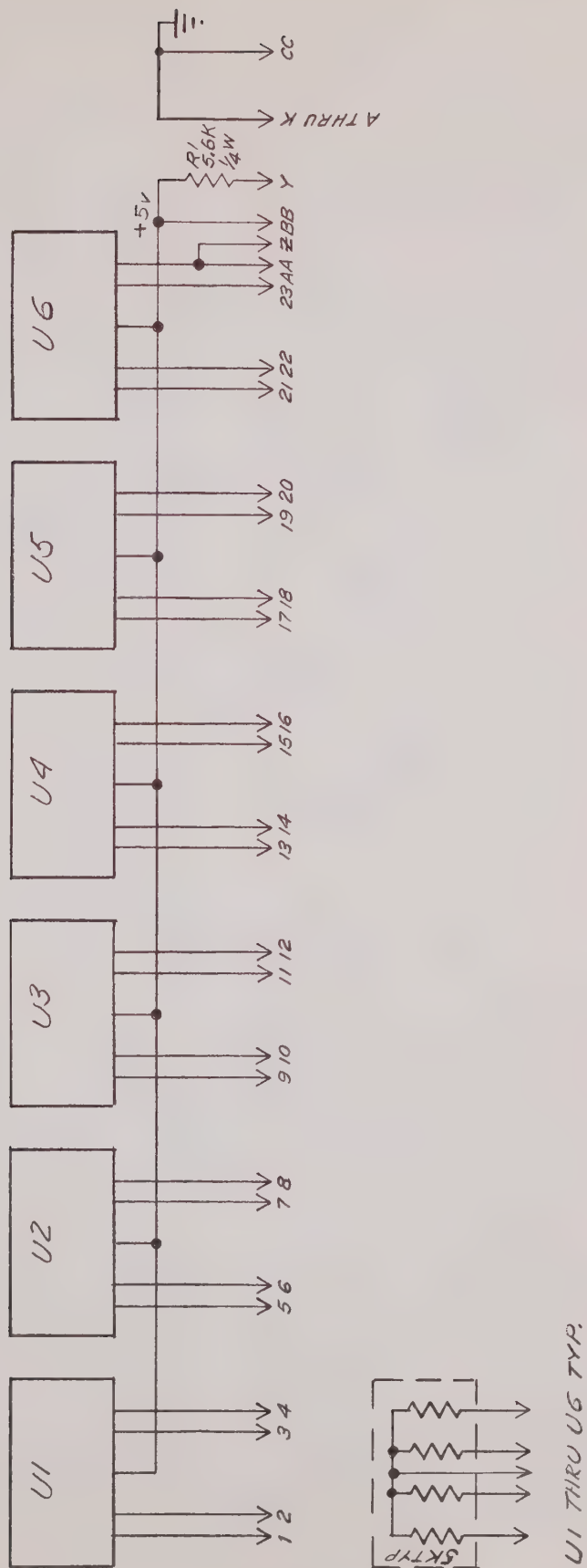
NOTE: UNLESS OTHERWISE NOTED  
 1.) RESISTORS — 1/4W, 5%  
 2.) \* INDUCTORS L2, L3, L4 & L5 ARE CUSTOM

A4, 100 MHz MULTIPLIER SCHEMATIC #C39360B

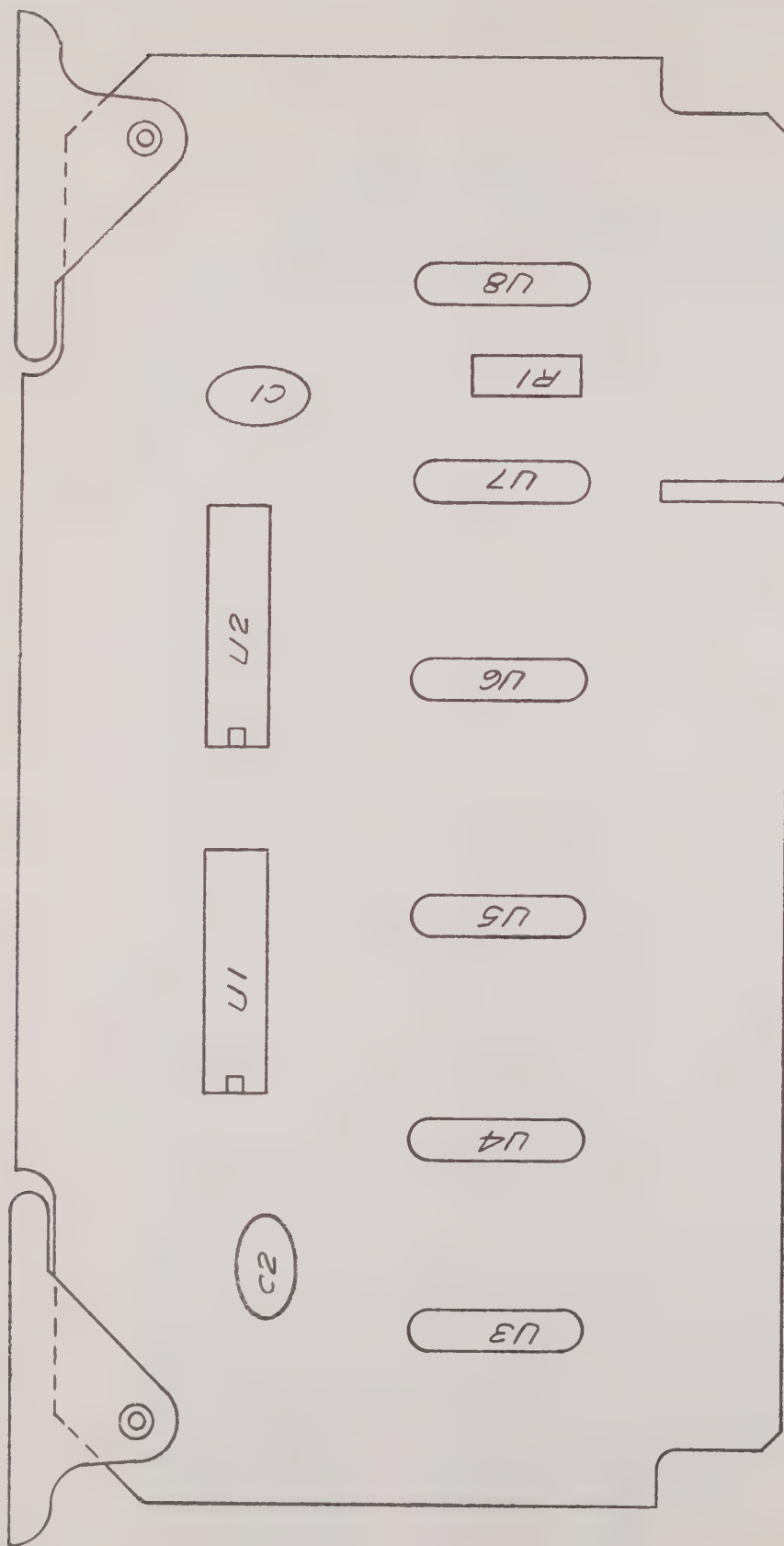




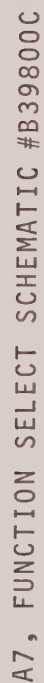
A6, ATTENUATOR SELECT P.C. ASSEMBLY #B39355A

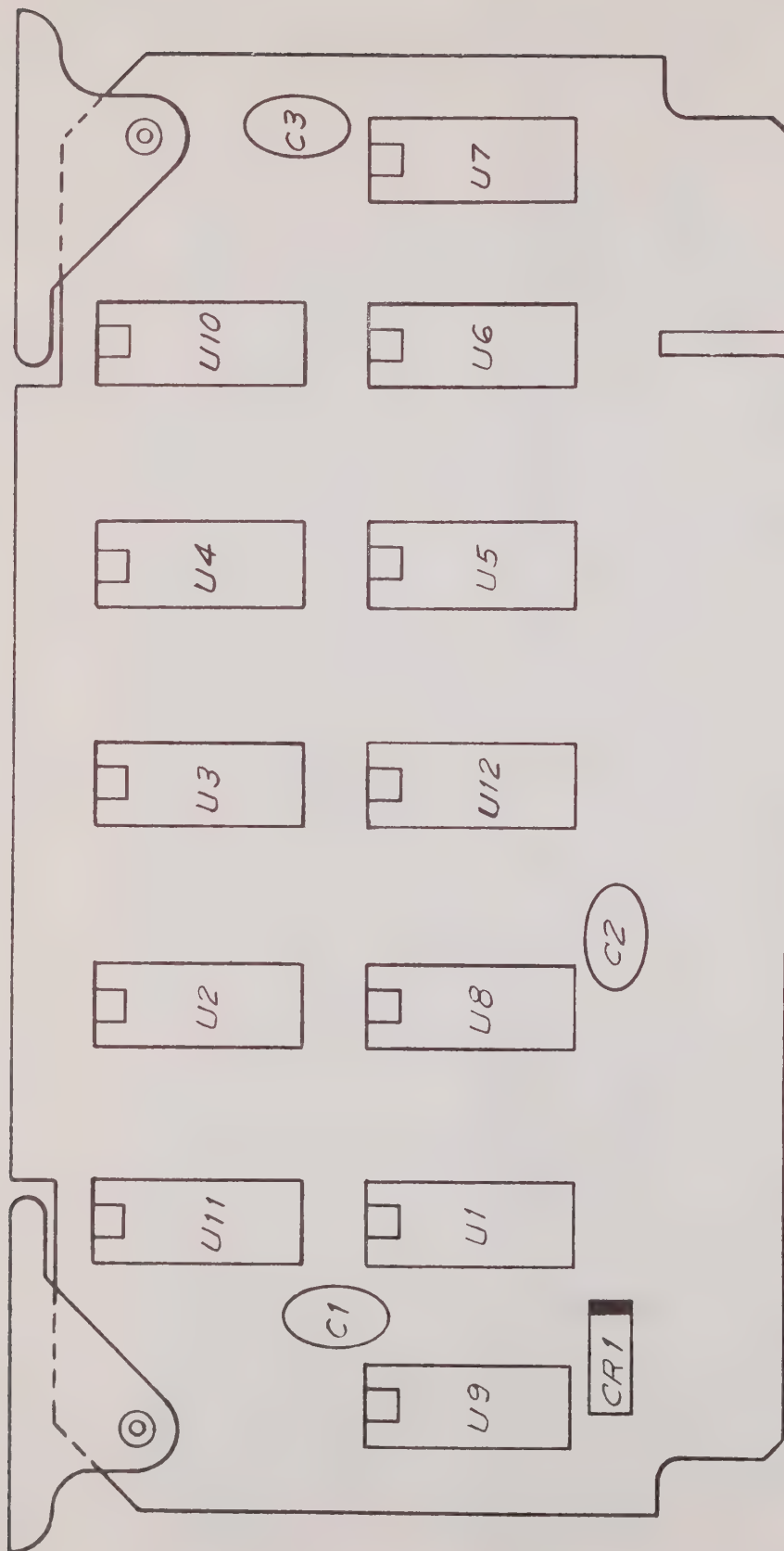


A6, ATTENUATOR SELECT SCHEMATIC #B39352C



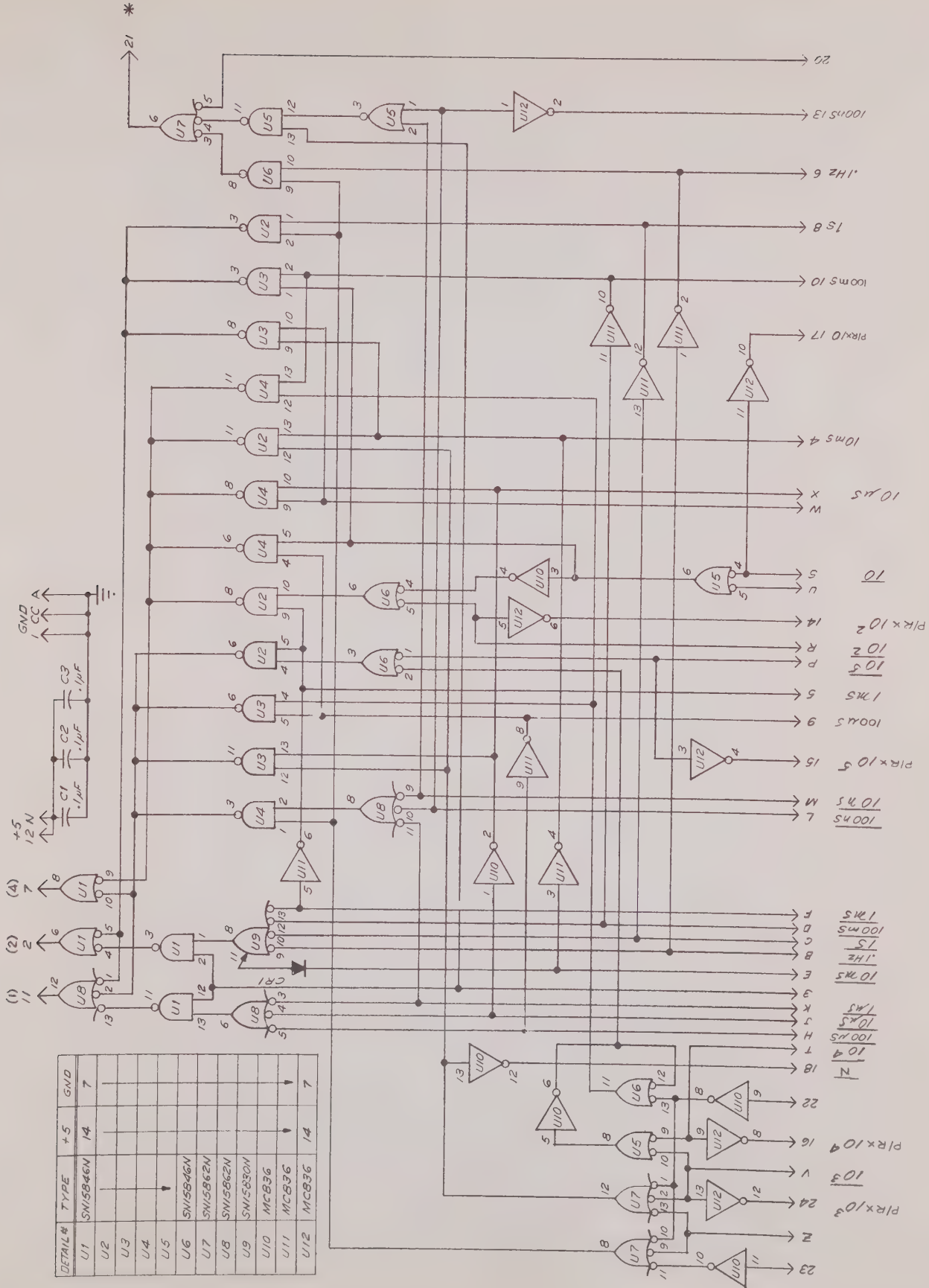
A7, FUNCTION SELECT P.C. ASSEMBLY #B39803A



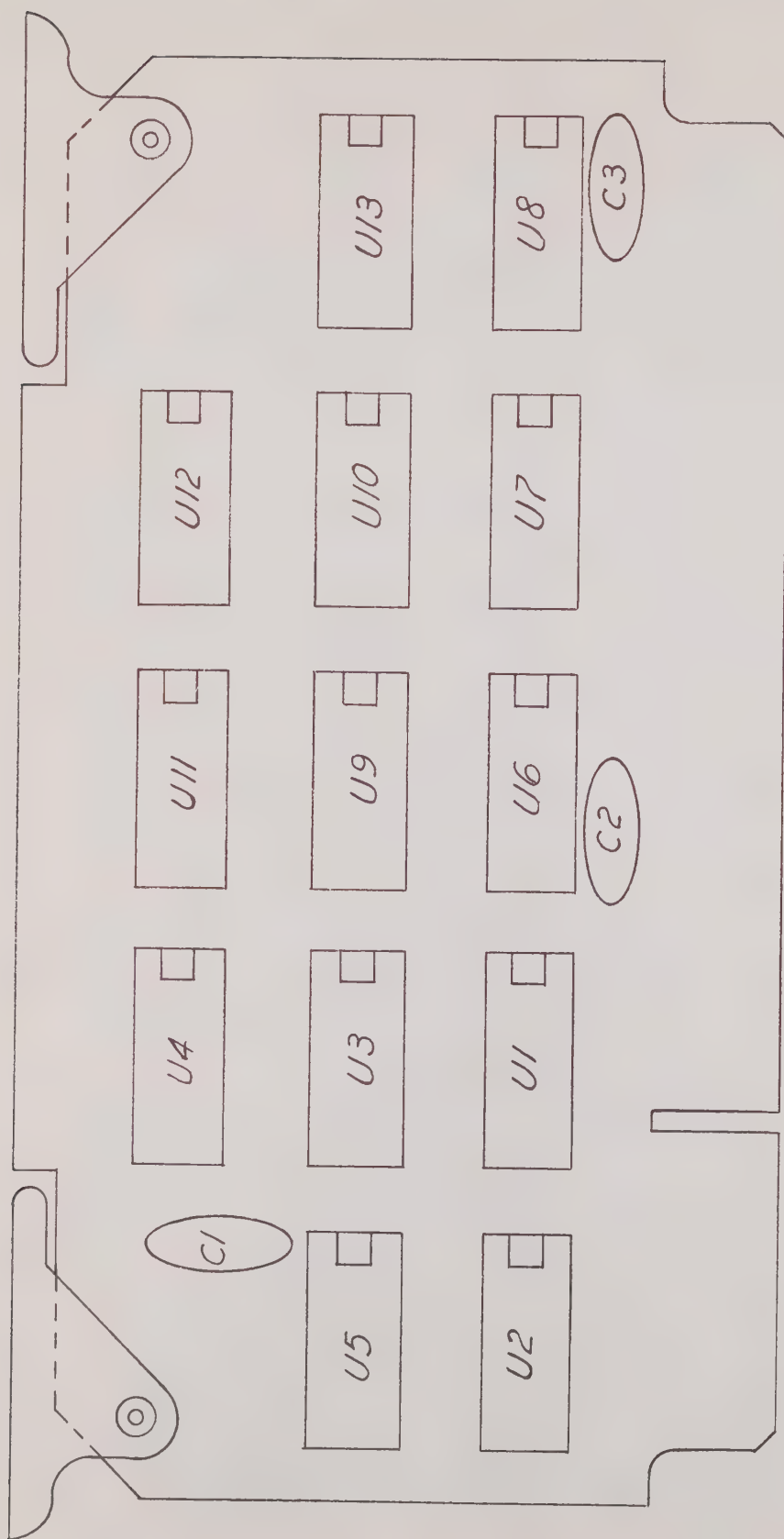


A8, LEGEND LOGIC P.C. ASSEMBLY #B39335A



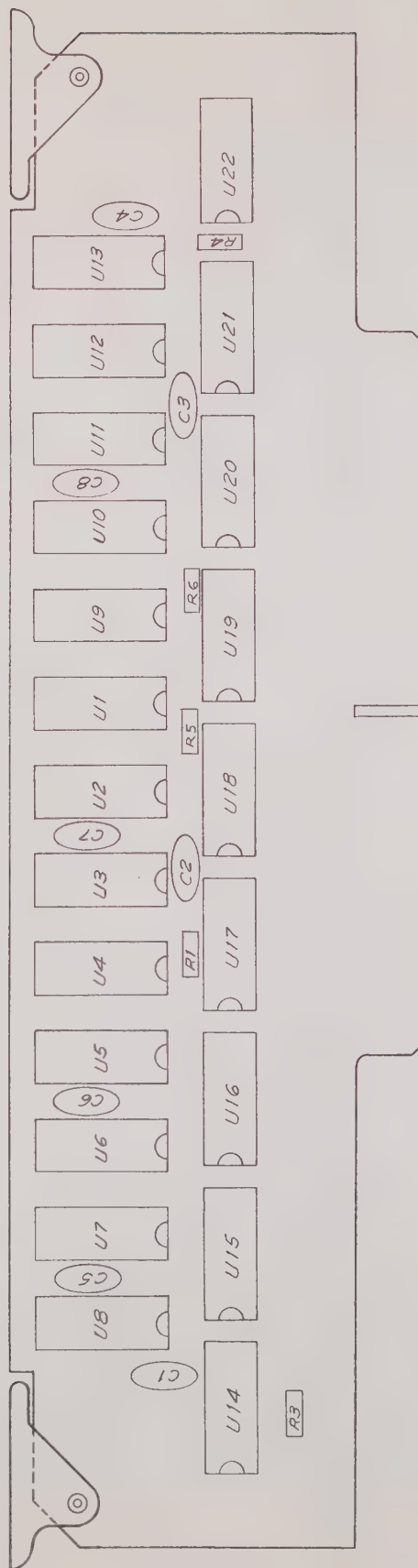


A8, LEGEND LOGIC SCHEMATIC #C39332A

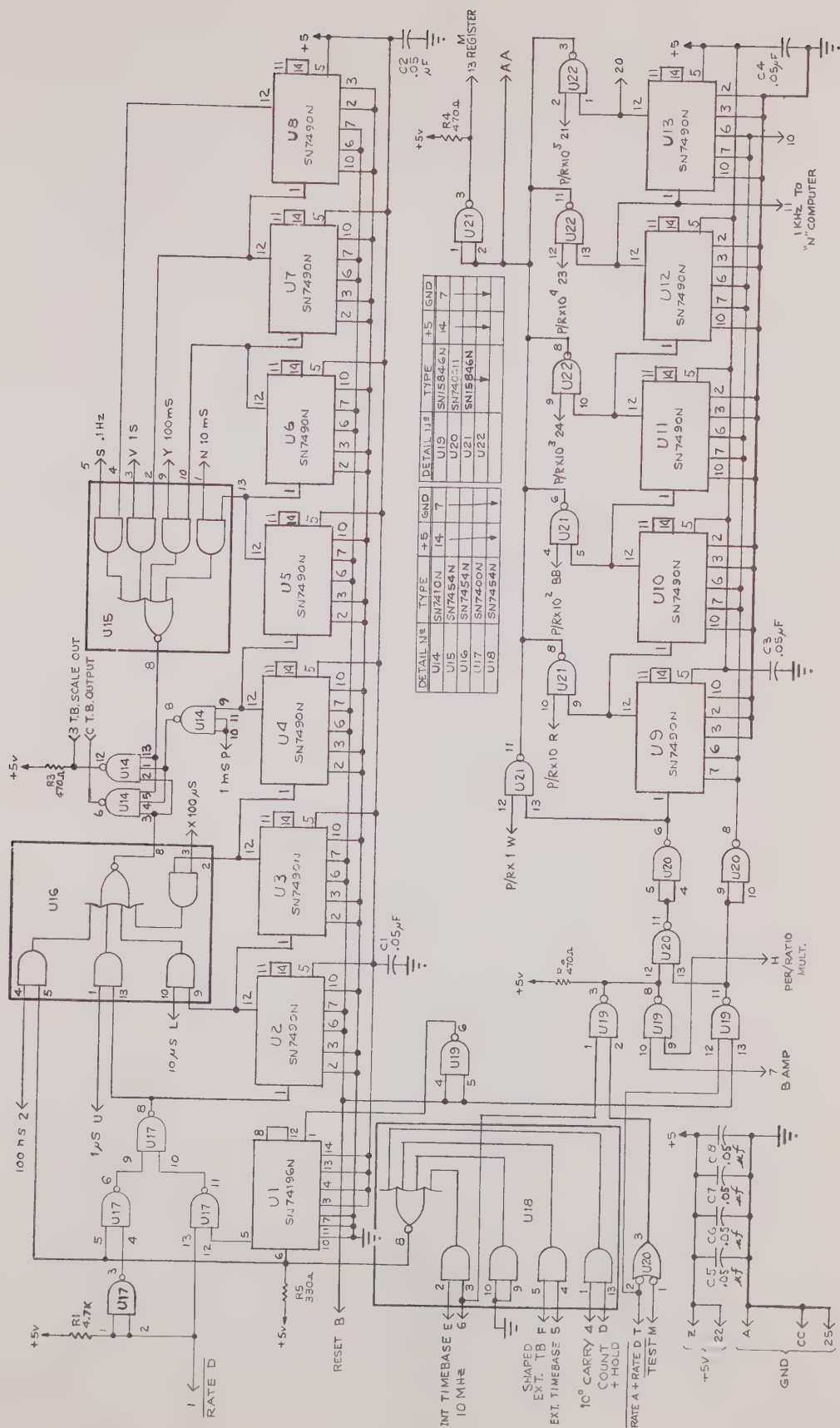


A9, DECIMAL LOGIC P.C. ASSEMBLY #B39339A



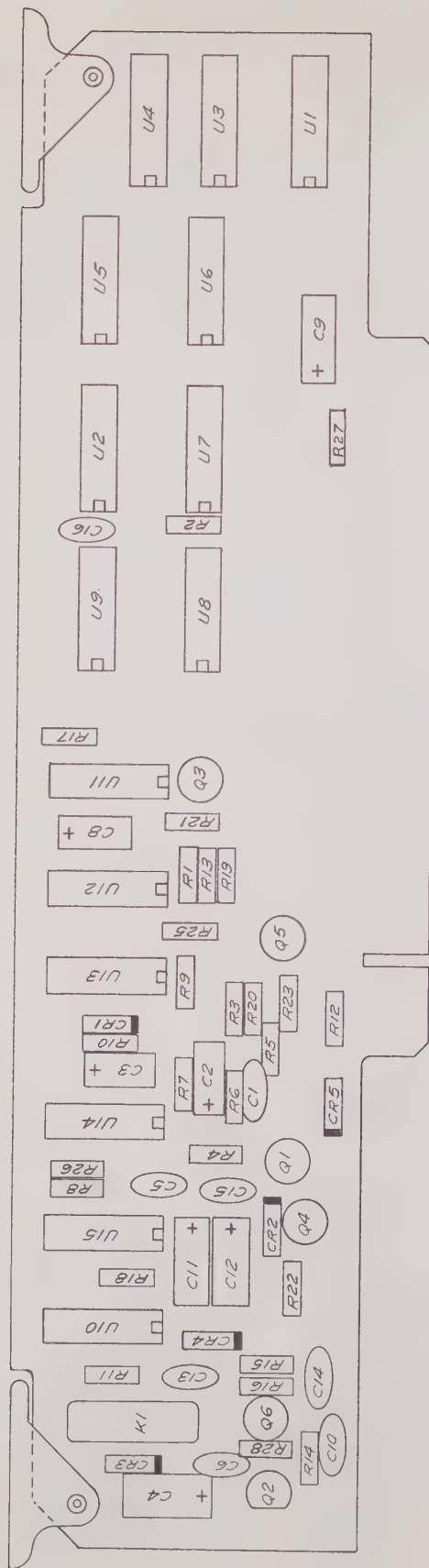


A10, TIME BASE P.C. ASSEMBLY #C39347C

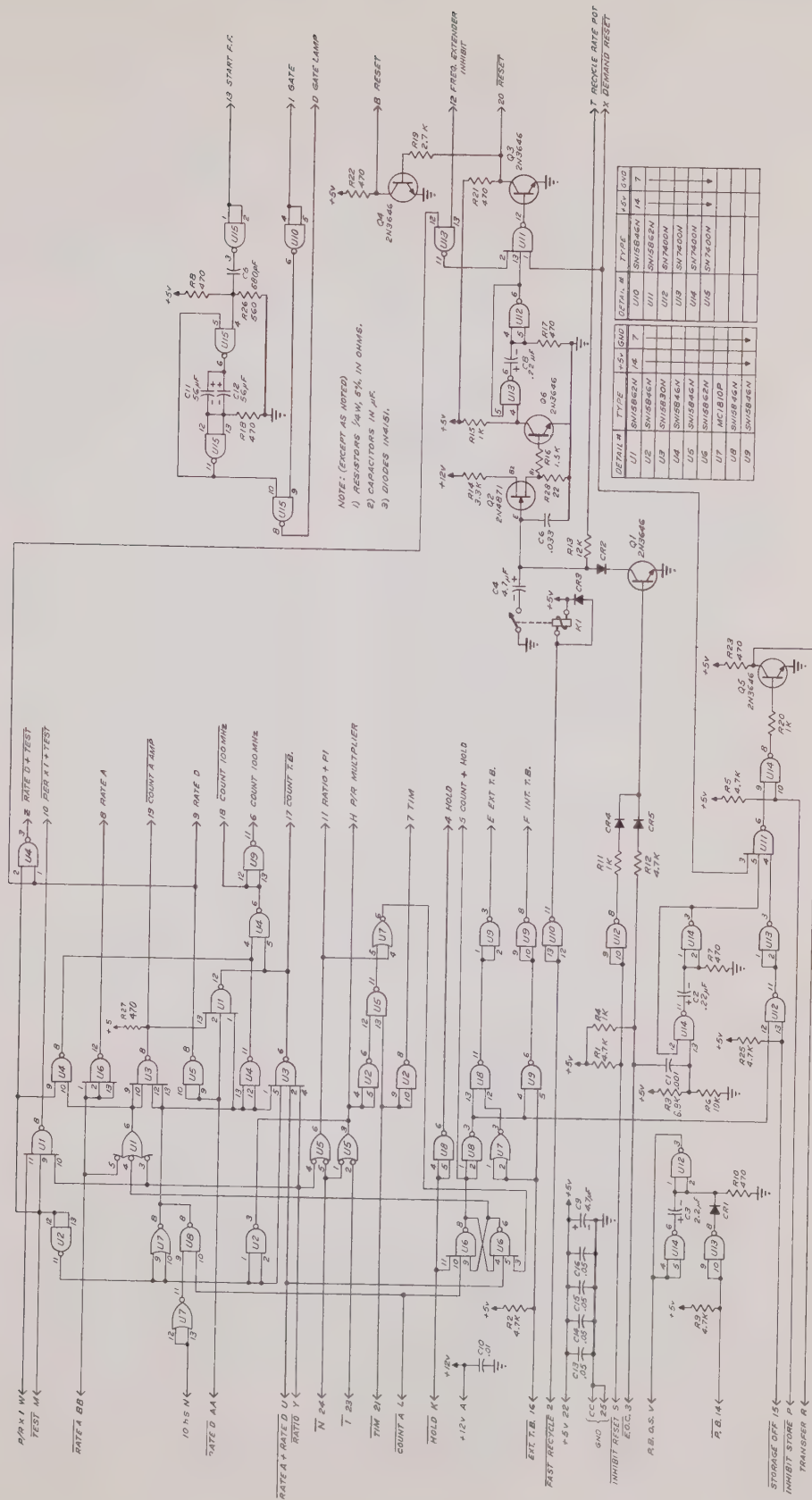


A10, TIME BASE SCHEMATIC #C39344C

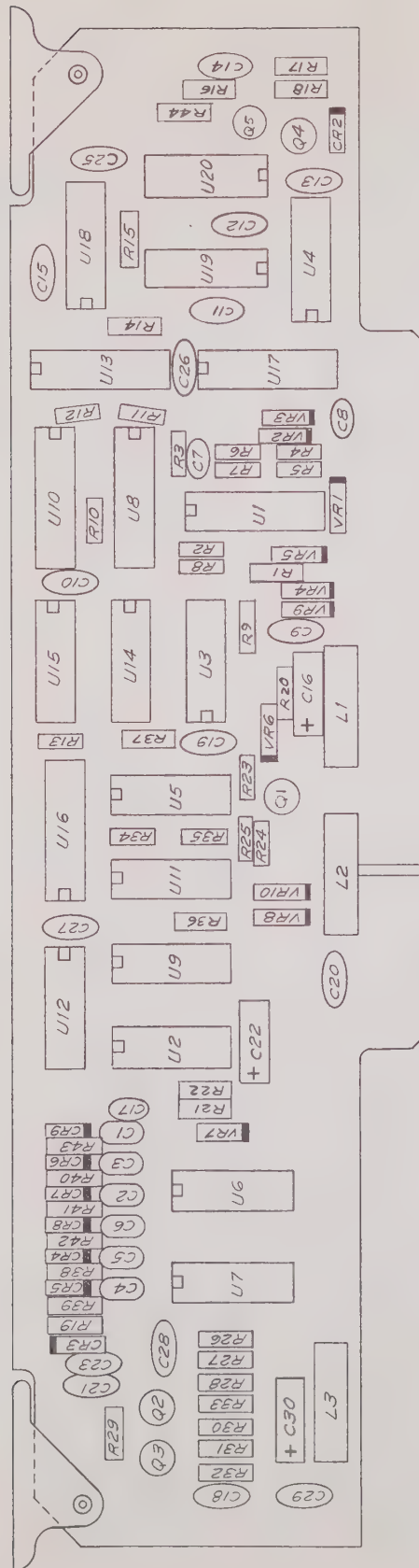




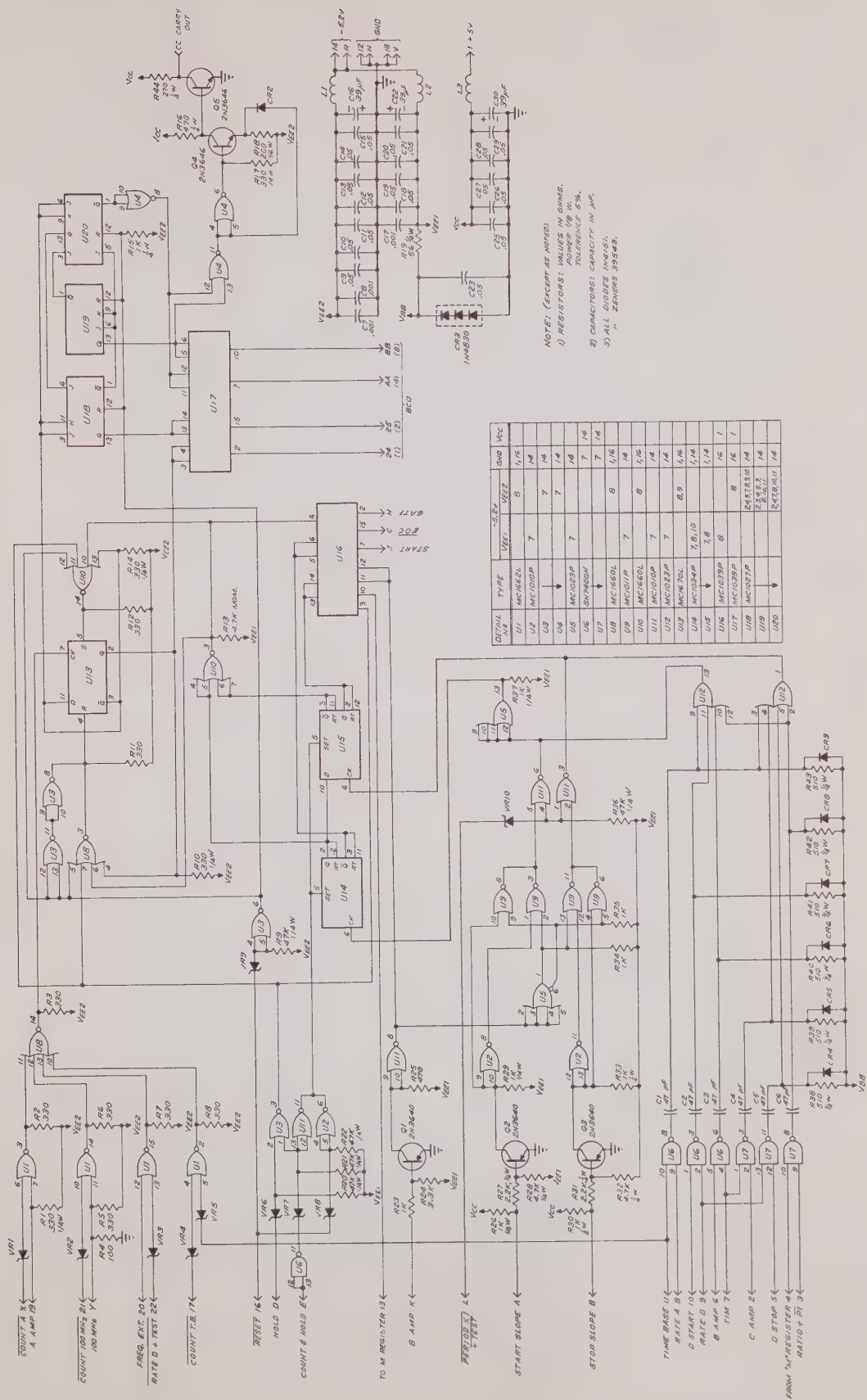
A11, FUNCTION CONTROL P.C. ASSEMBLY #C39343G



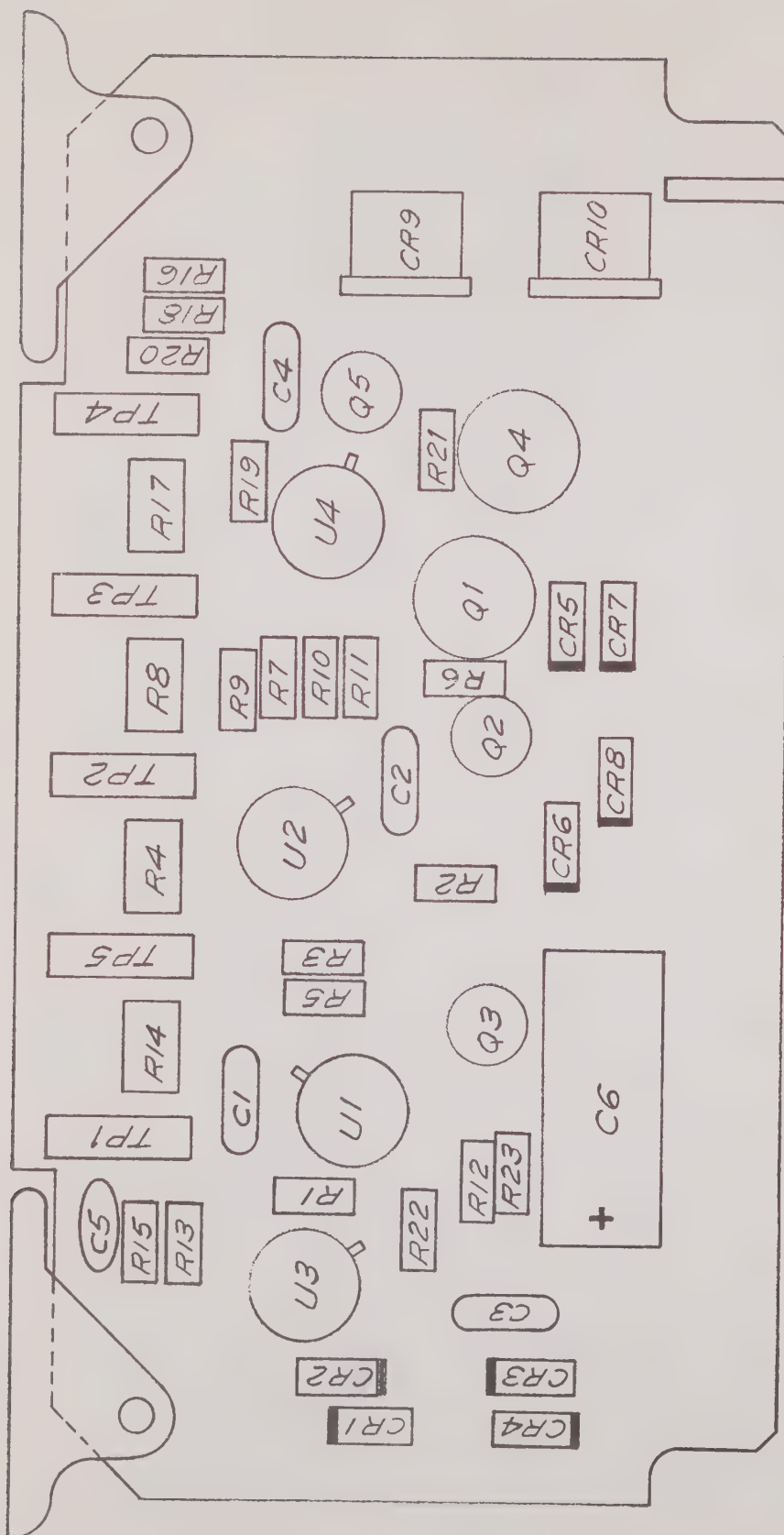
A11, FUNCTION CONTROL SCHEMATIC #D39340G



A12, 200 MHZ DECADE & GATE P.C. ASSEMBLY #C39327C



A12, 200 MHz DECADE &amp; GATE SCHEMATIC #D39324C

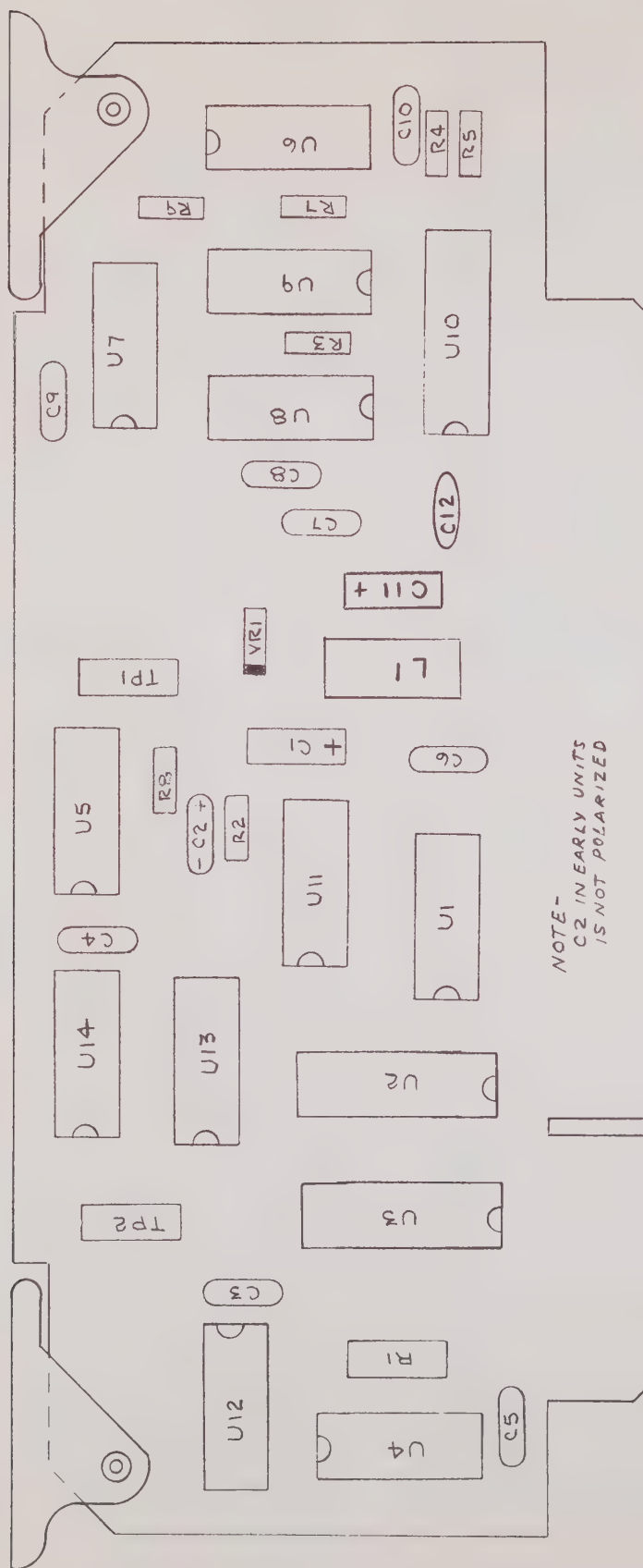


A13, MAIN POWER P.C. ASSEMBLY #B39351A

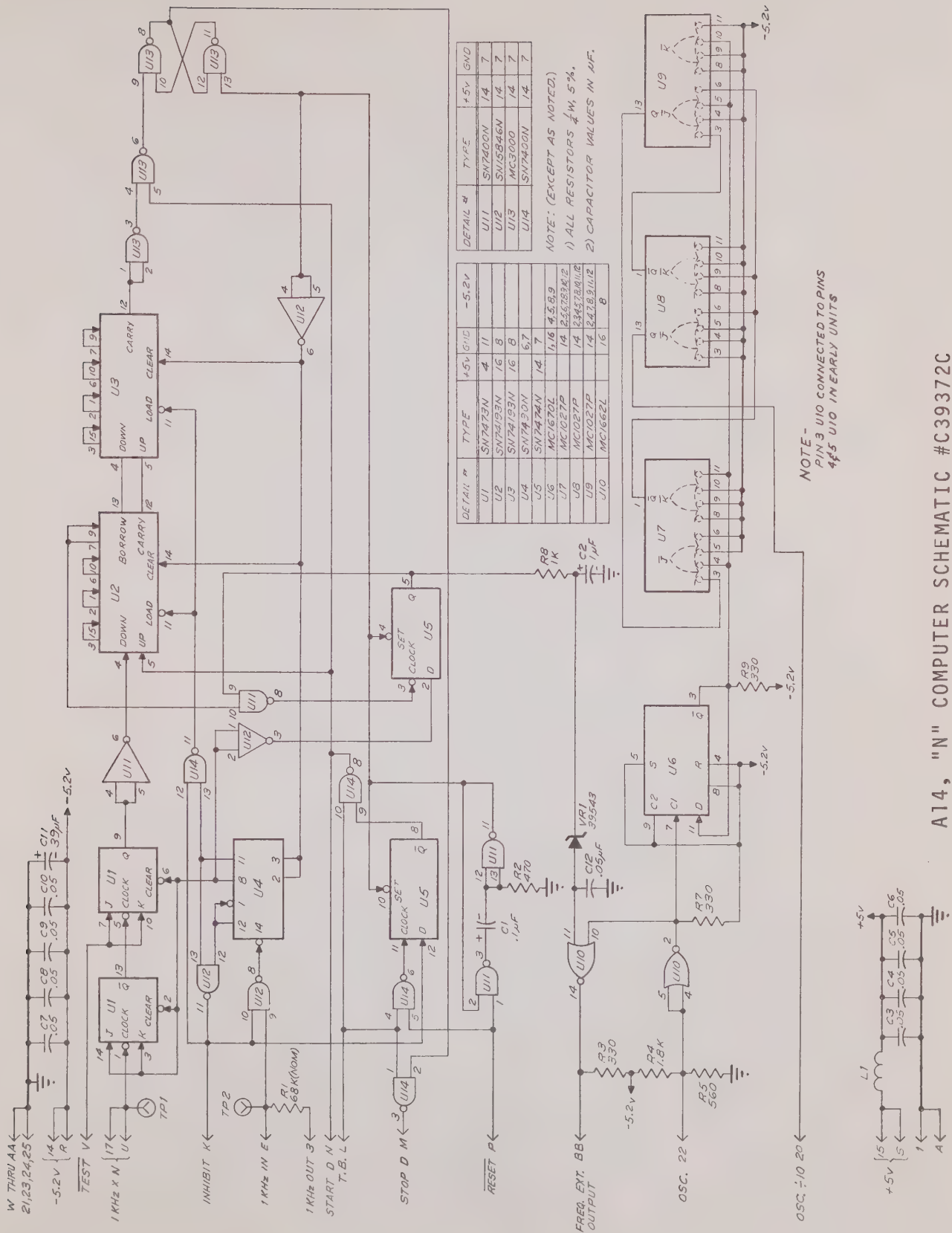


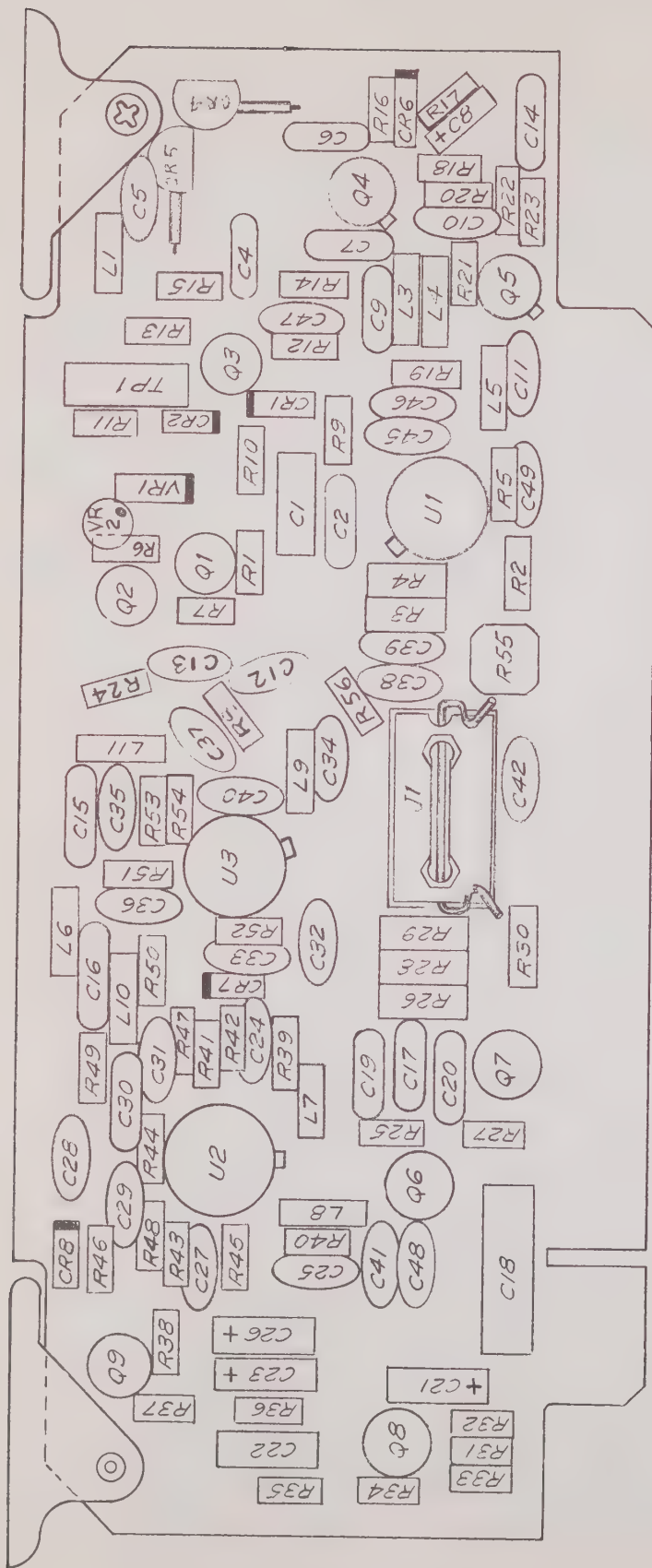


7-37

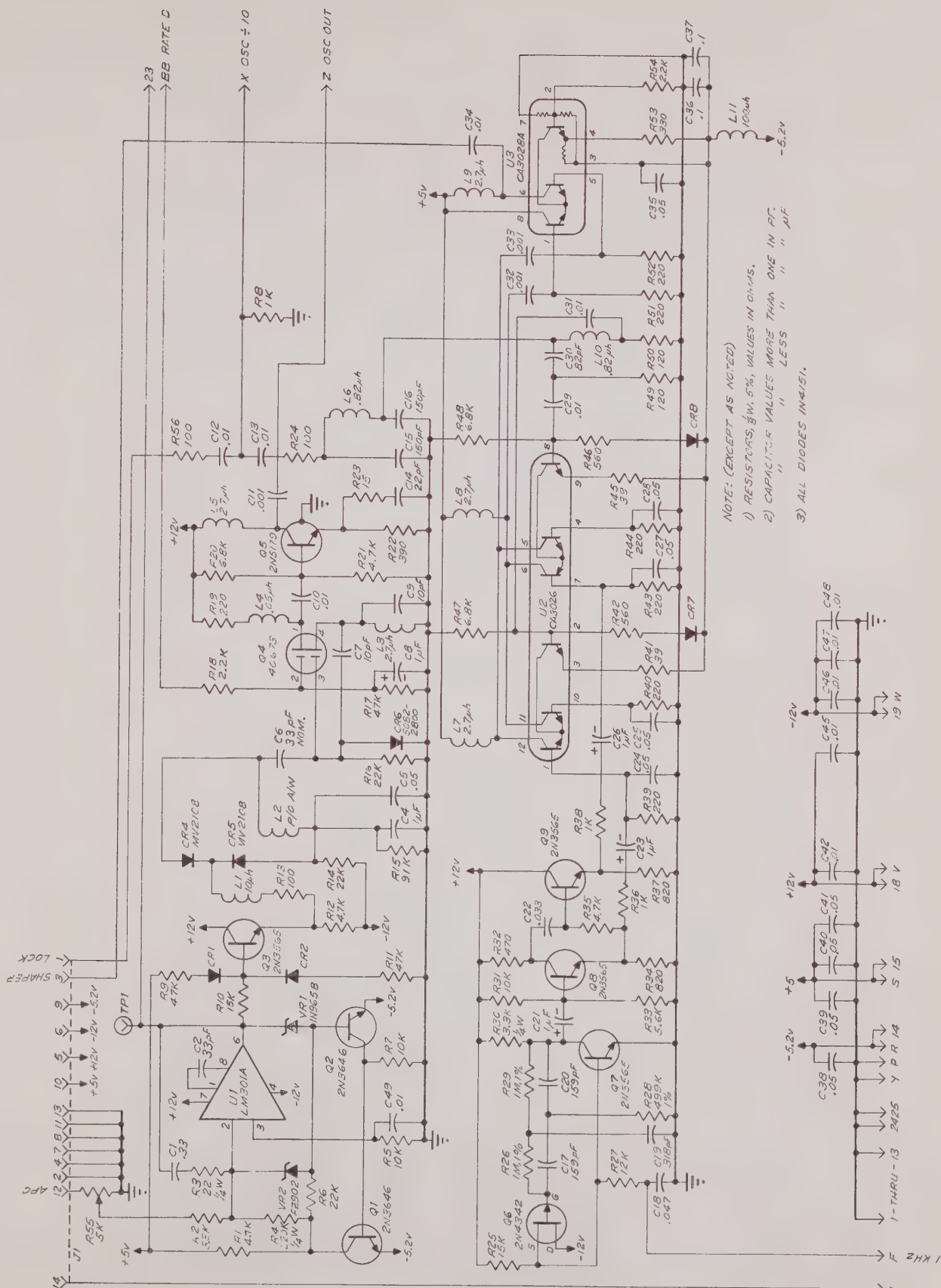


A14, "N" COMPUTER P.C. ASSEMBLY #B39375C

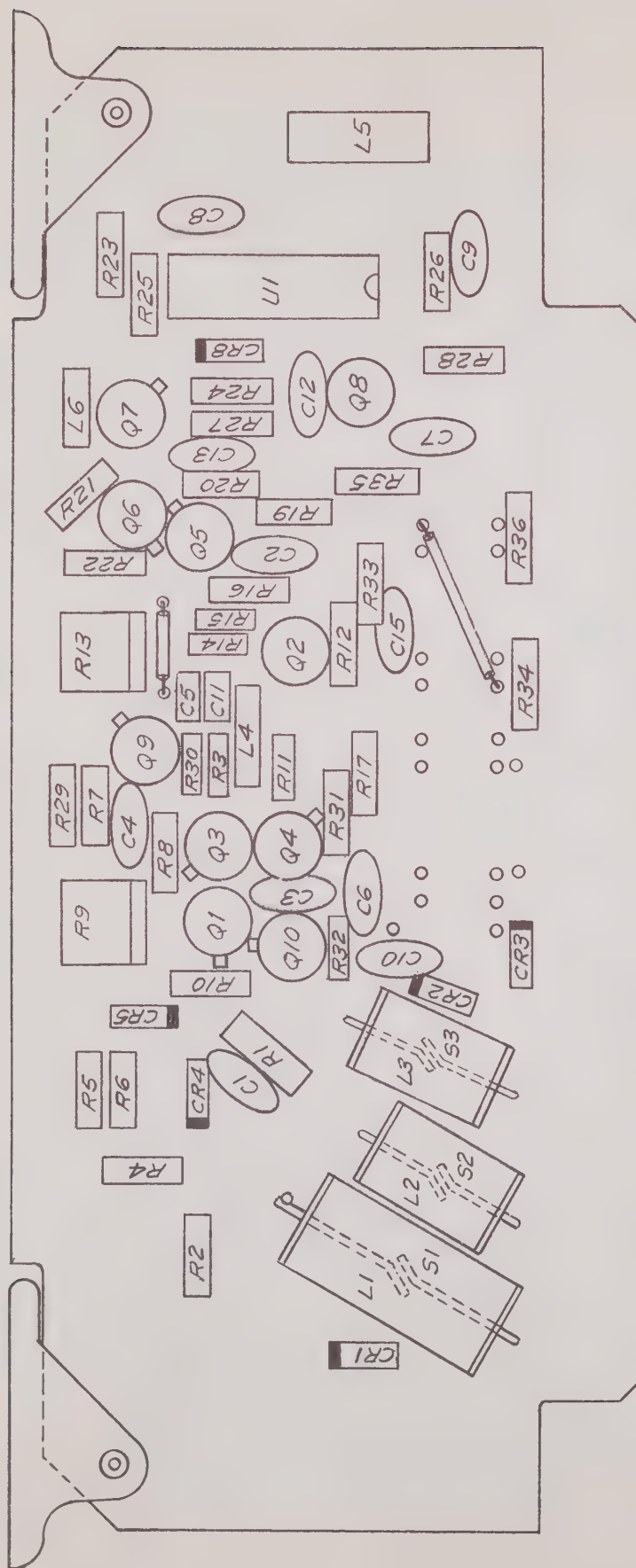




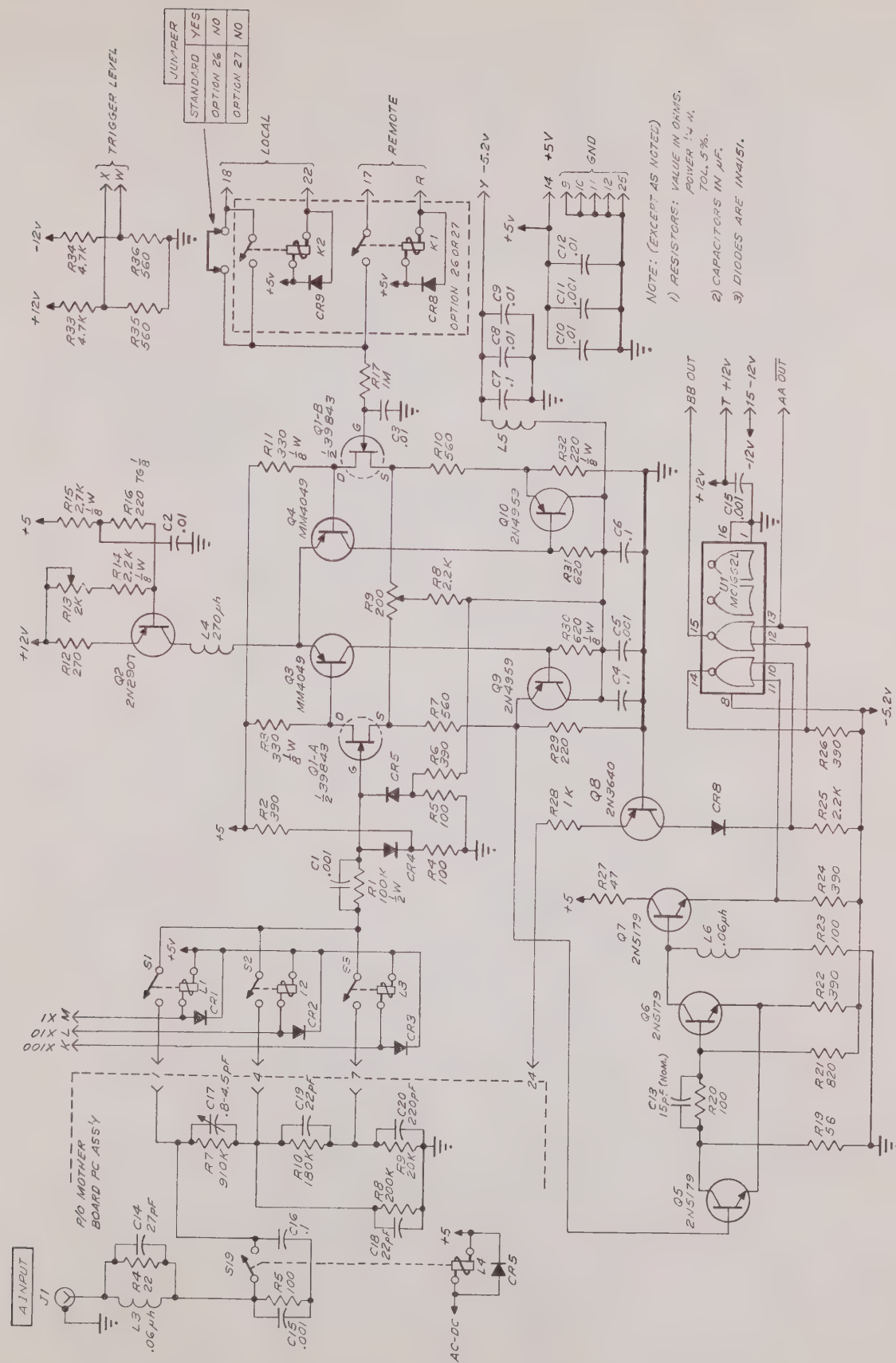
A15, SHIFTER P.C. ASSEMBLY #C39371G



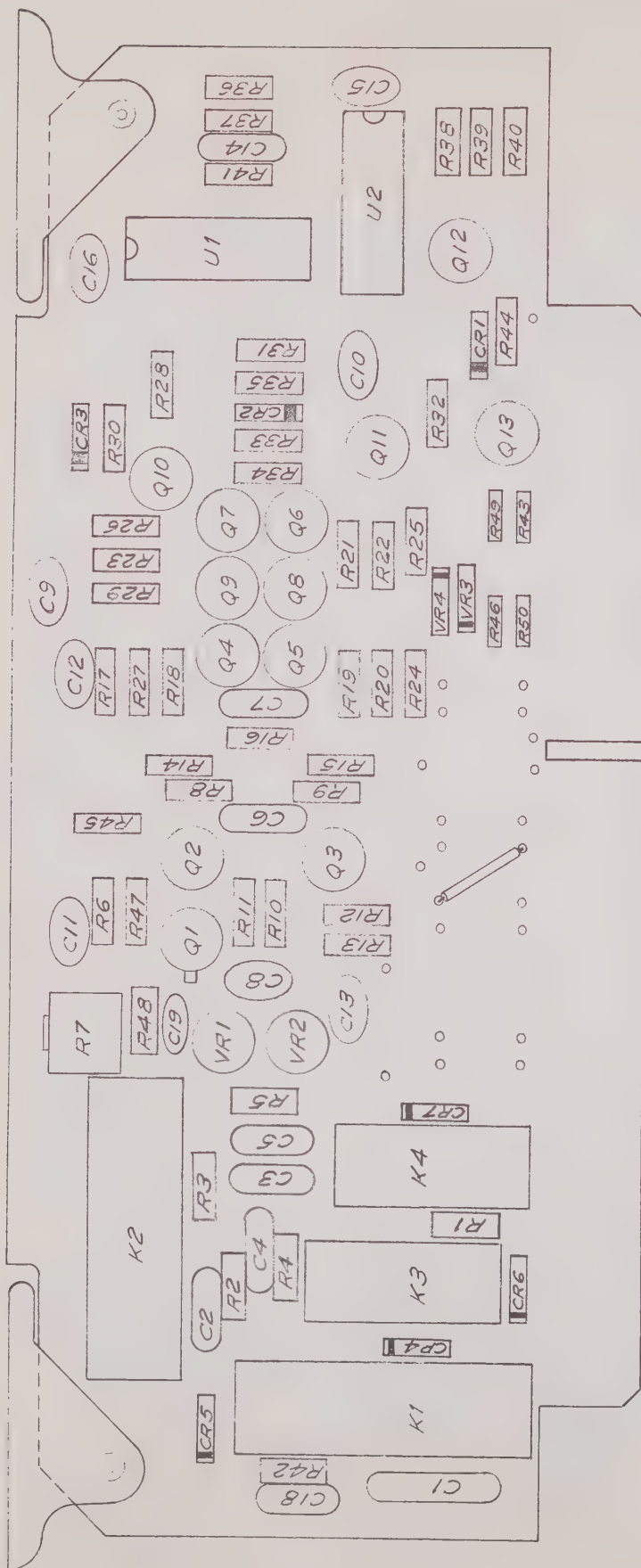




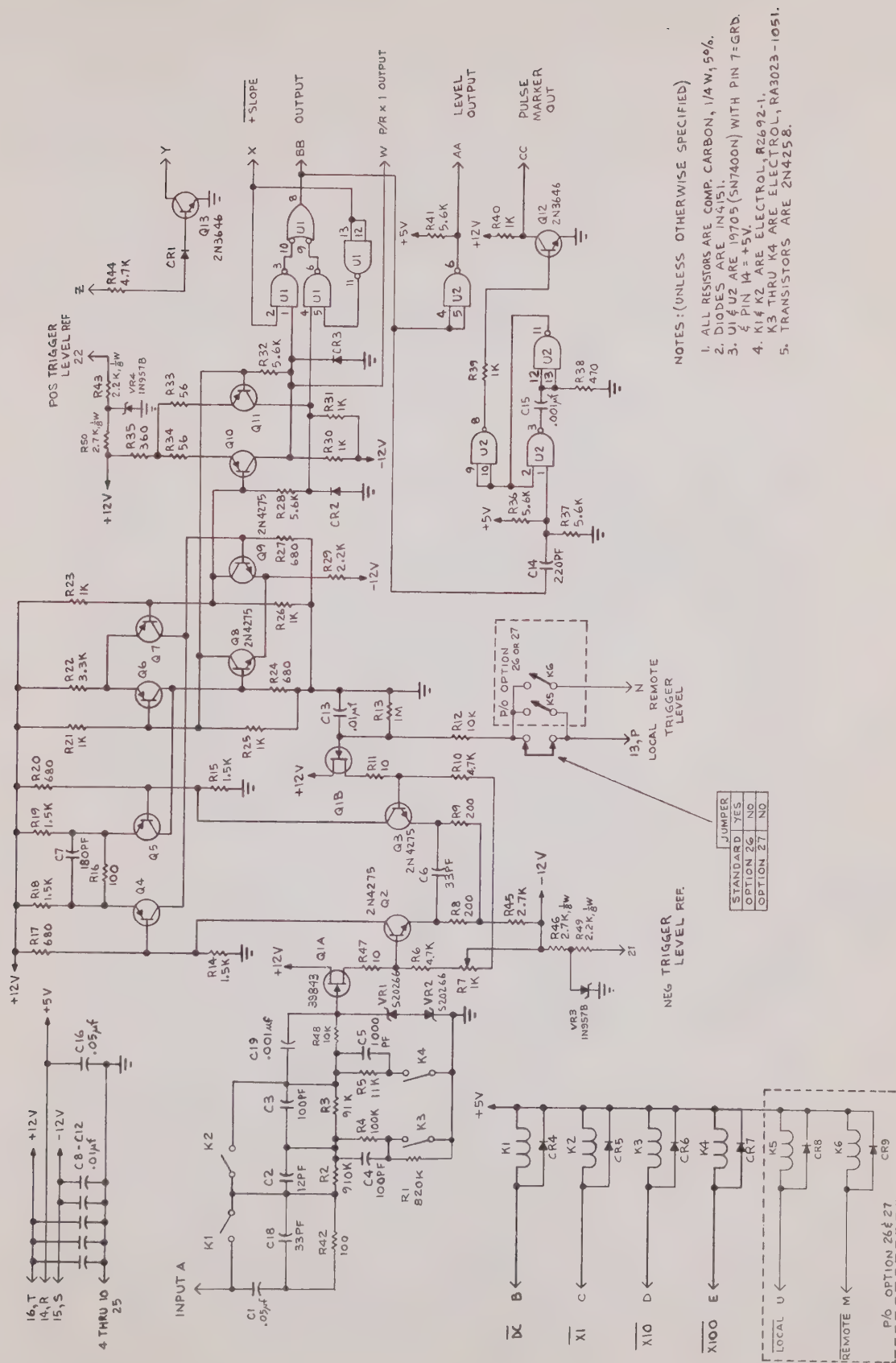
A16, 200 MHz AMPLIFIER P.C. ASSEMBLY #B39323E



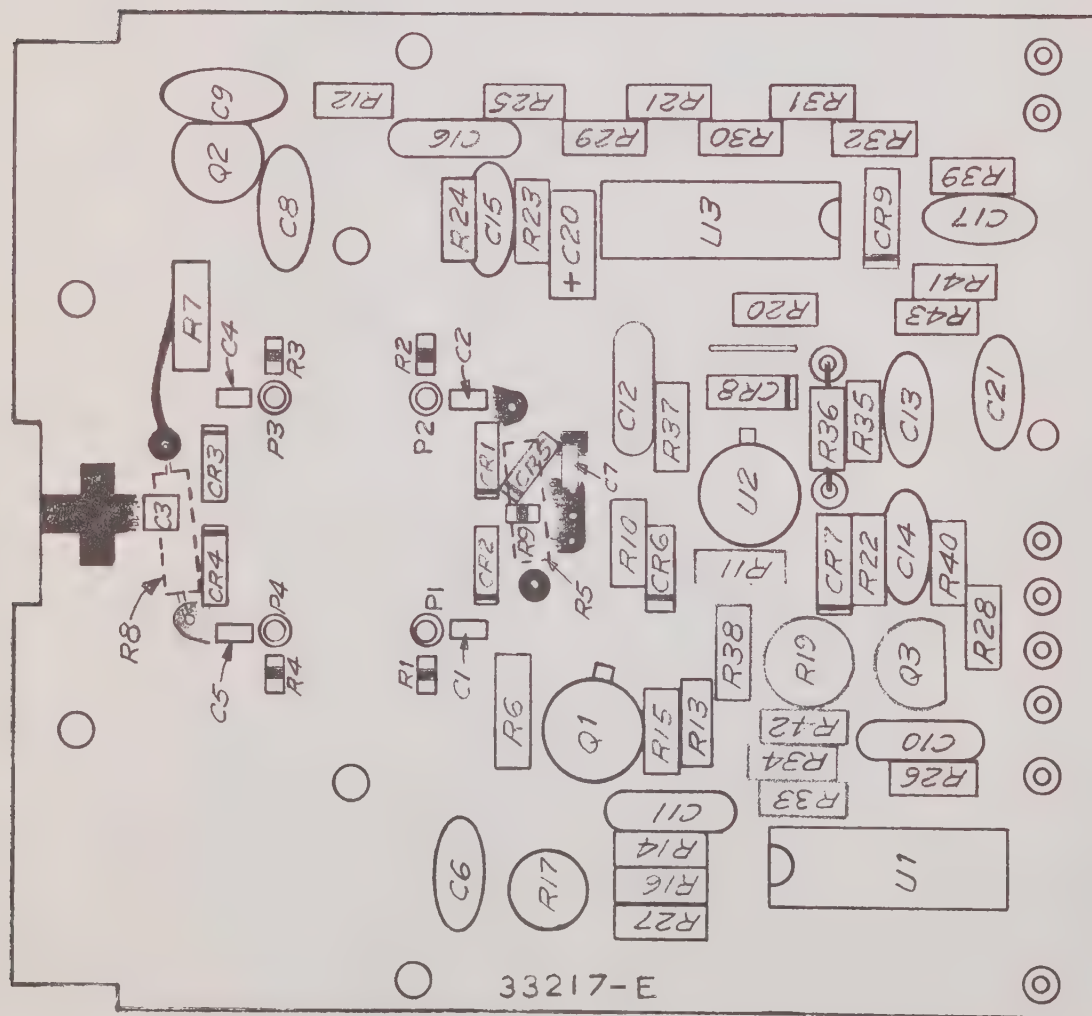
A16, 200 MHz AMPLIFIER SCHEMATIC #C39320G



A18, A19, 10 MHz AMPLIFIER P.C. ASSEMBLY #B39331B



A18, A19, 10 MHz AMPLIFIER SCHEMATIC #C39328D

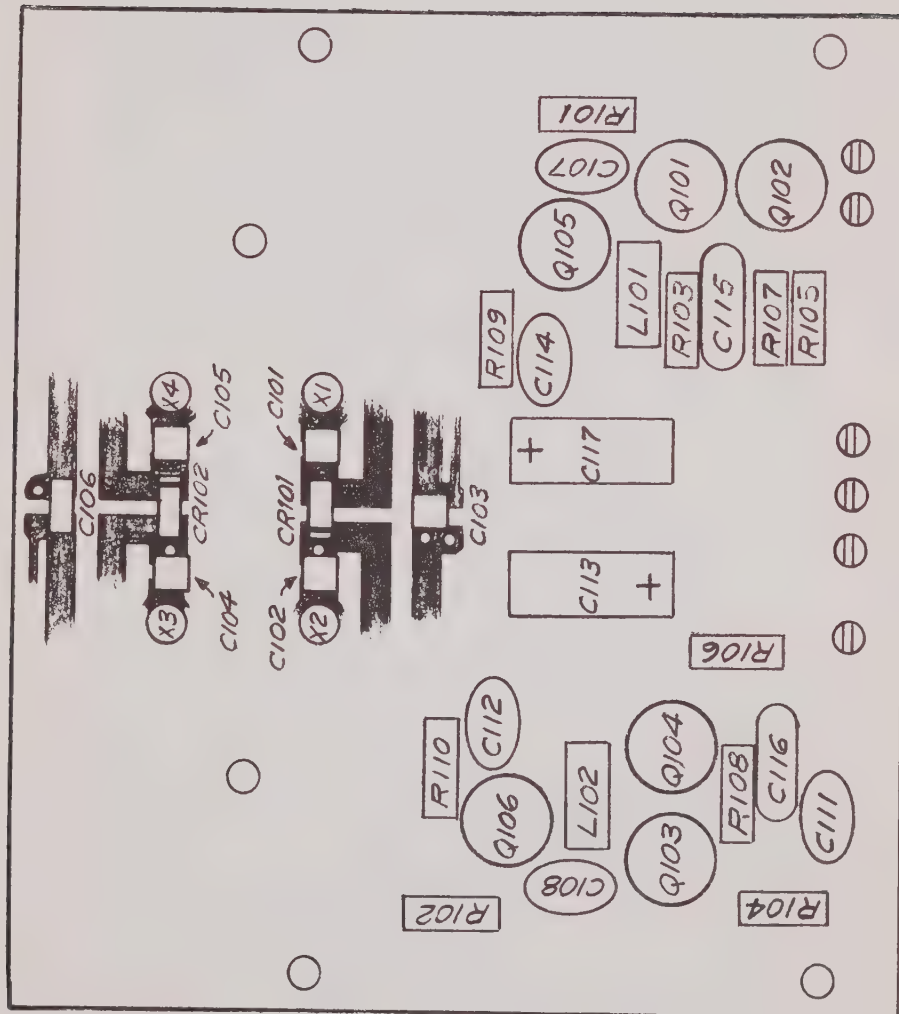


NOTE:

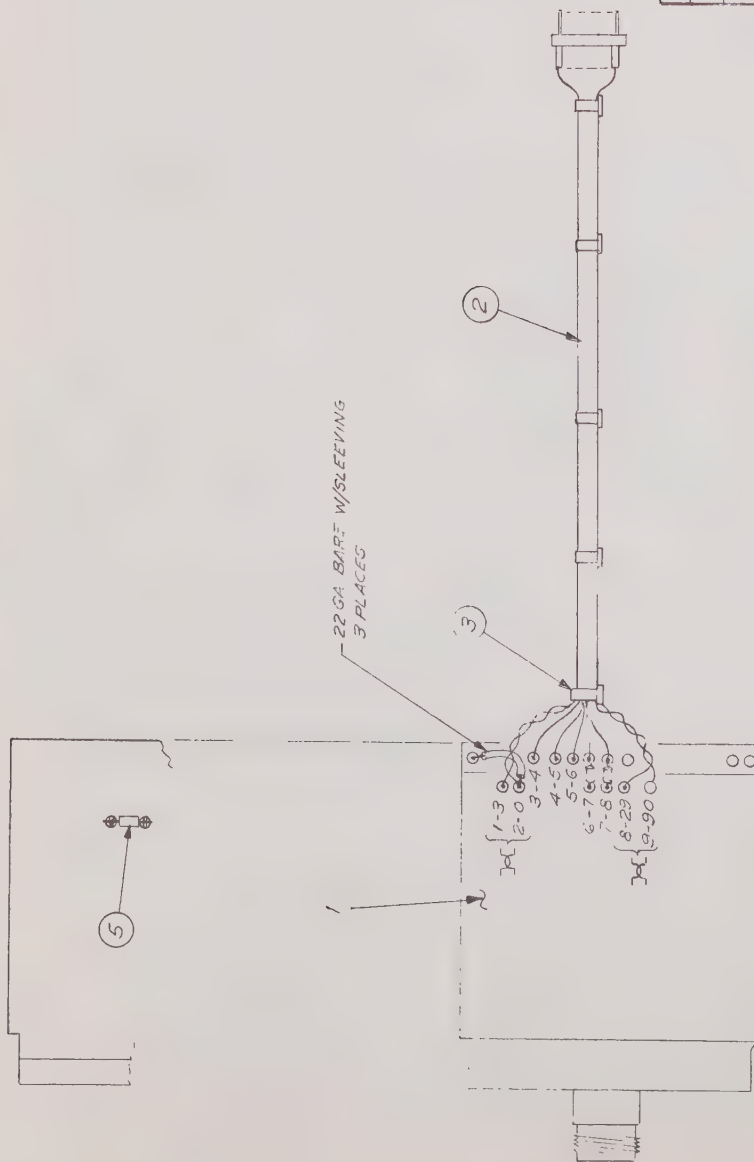
- 1) RESISTORS  $\frac{1}{8}W$ , 5% SPECIFIED IN OHMS.
- 2) CAPACITORS - MORE THAN "ONE" IN PF.  
-LESS " " " "  $\mu F$ .
- 3) INSTALL R1, R2, R3, R4 & R9 BLACK  
SIDE UP, CENTERED ON TRACE WITH  
LOW TEMPERATURE SOLDER.
- 4) CONDUCTIVE CEMENT ON CHIP  
CAPACITORS, (ECOBAND 56C OR EQUIV.)  
CURE MIN. 2 HOURS @ 55°C.
- 5) A RESISTOR IS USED ON SOME EARLY UNITS  
FROM TPI TO THE +5V OR -5V LUG, THE  
VALUE IS SOME 5% INCREMENT BETWEEN  
20K & 100K

A20, MIXER P.C. ASSEMBLY #C33218K





A20, DRIVER AMPLIFIER P.C. ASSEMBLY #C33221G

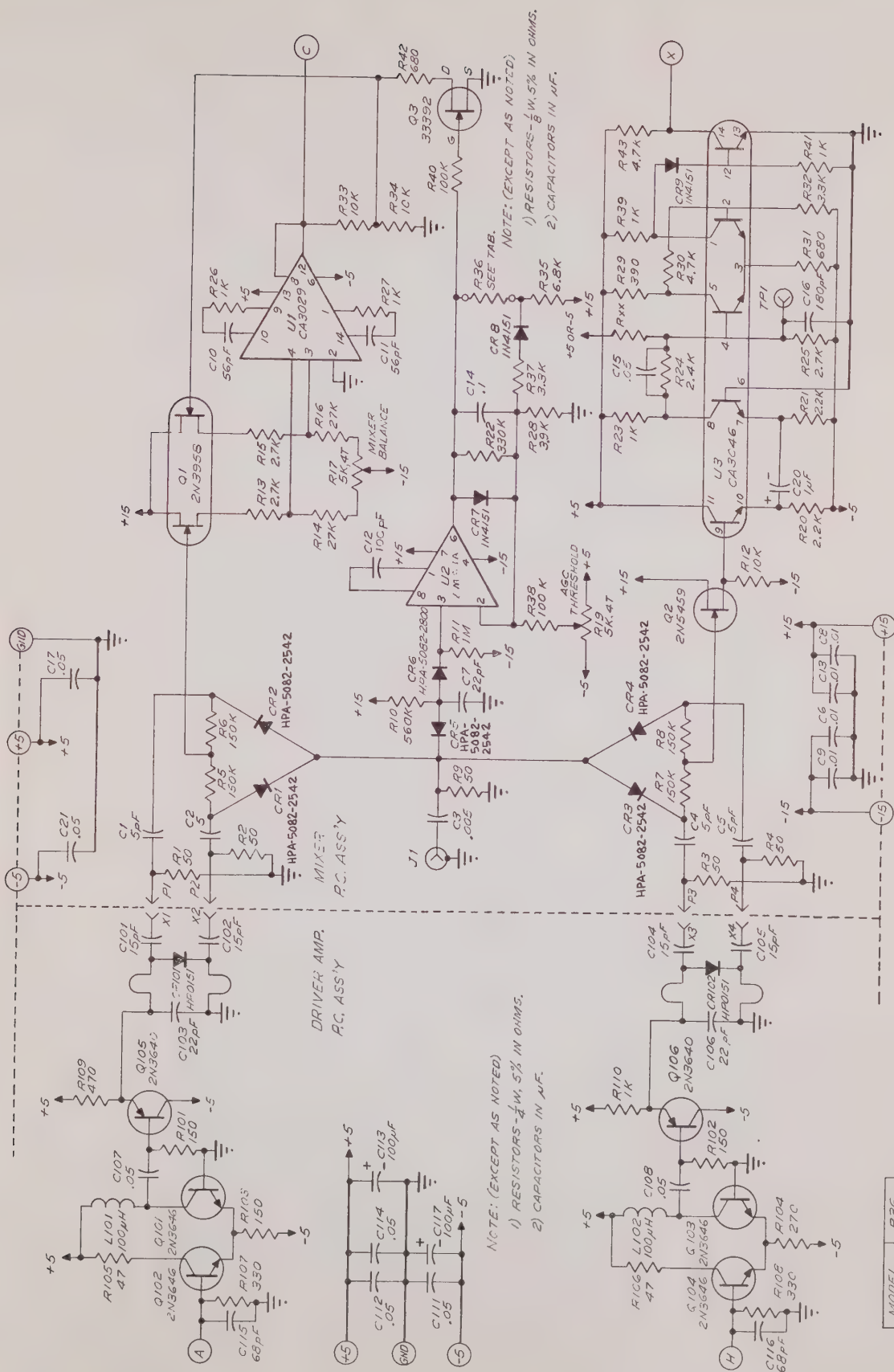


NOTE:

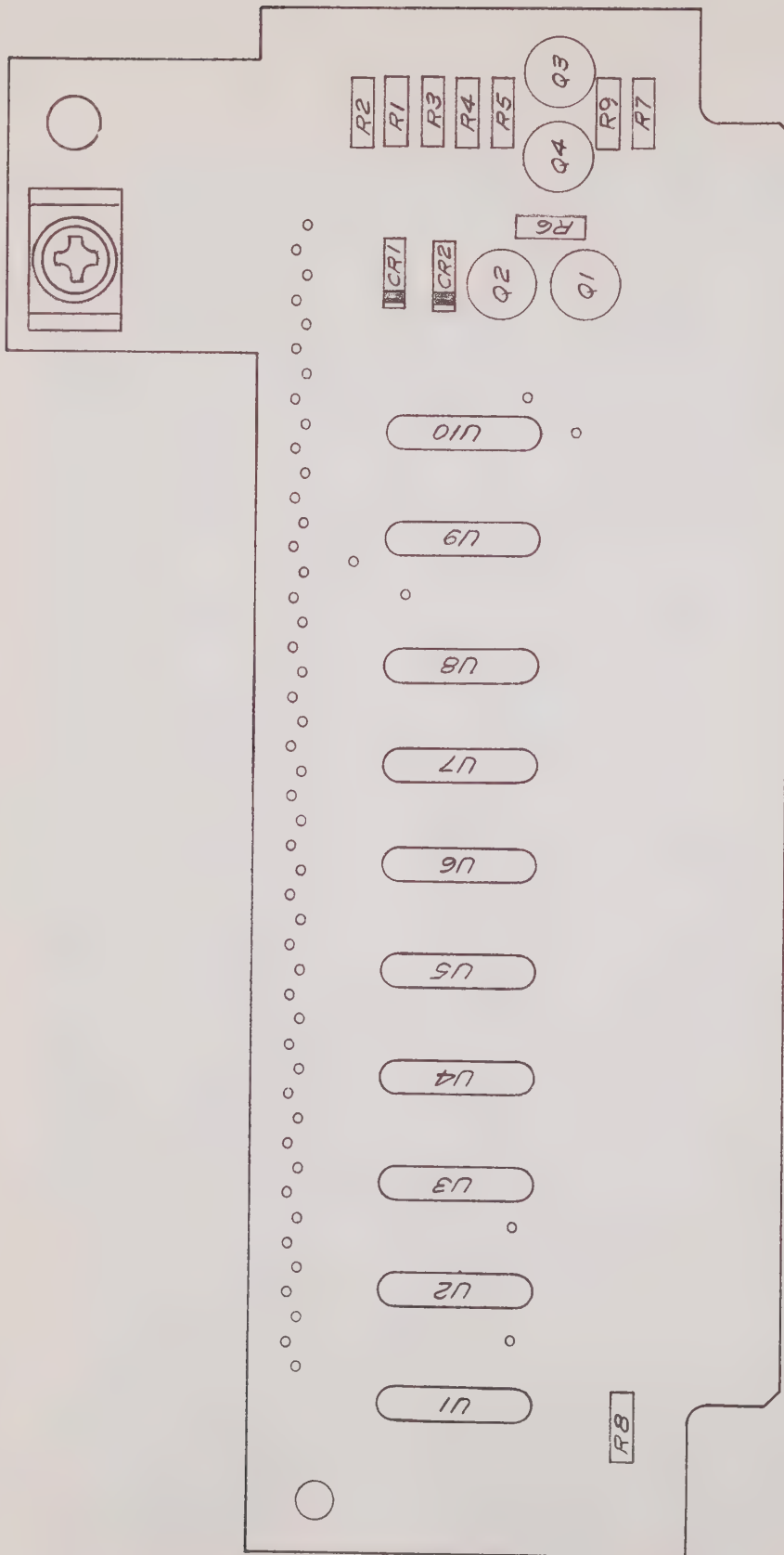
- 1) SOLDER WIRES & JUMPERS TO ITEM (1)
- 2) ADD 4 CABLE TIES.

| 5    | 1   | R 1455  | RESISTOR (R36, 1.5K 1/4W, 5%) |
|------|-----|---------|-------------------------------|
| 4    |     |         |                               |
| 3    | 4   | H-104   | CABLE TIE                     |
| 2    | 1   | A39783  | MIXER CABLE PLUG ASS'Y PI     |
| 1    | 1   | C3355   | MIXER ASS'Y                   |
| ITEM | QTY | PART NO | DESCRIPTION                   |

A20, MIXER CABLE ASSEMBLY #B39784C



A20, MIXER &amp; DRIVER AMPLIFIER SCHEMATIC #C27988L

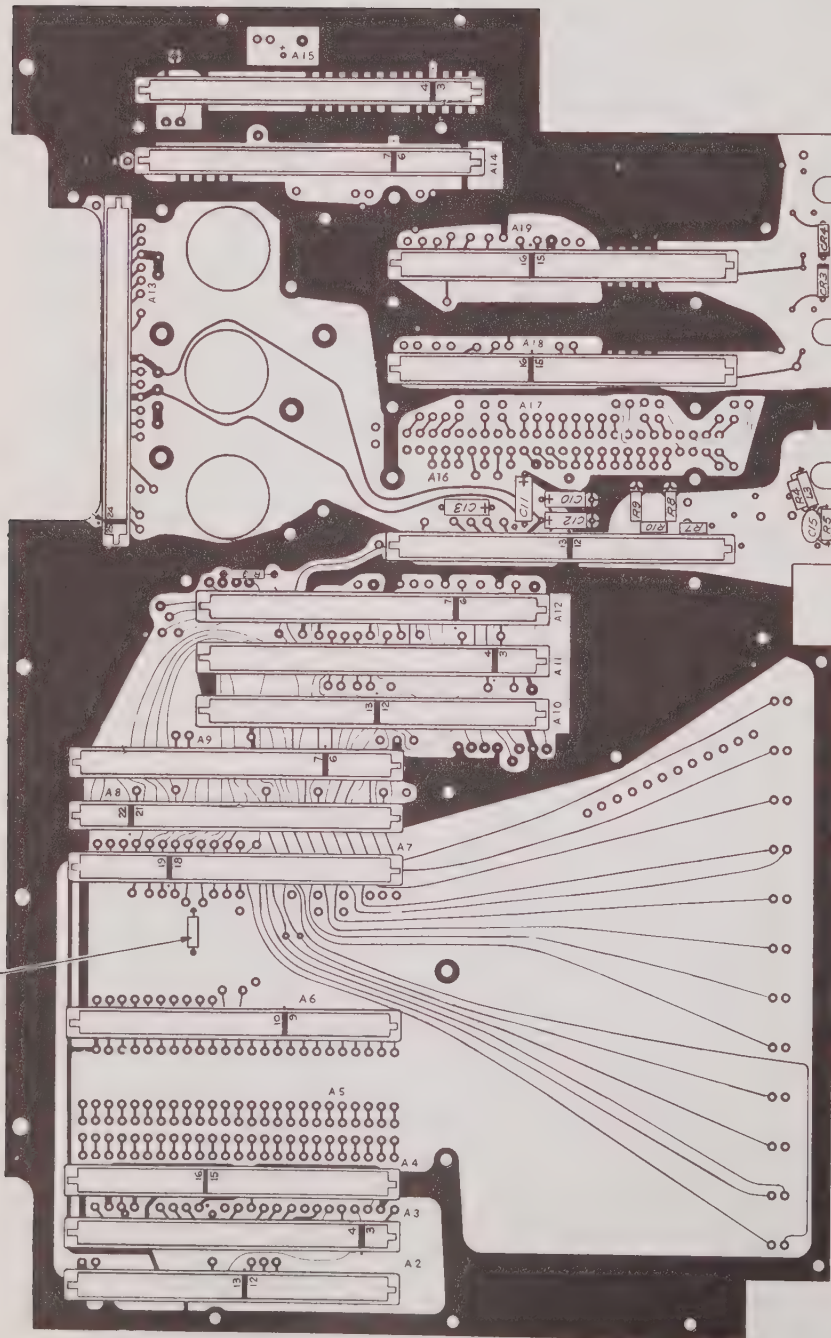


A1A2, BCD OUTPUT P.C. ASSEMBLY #B39379A



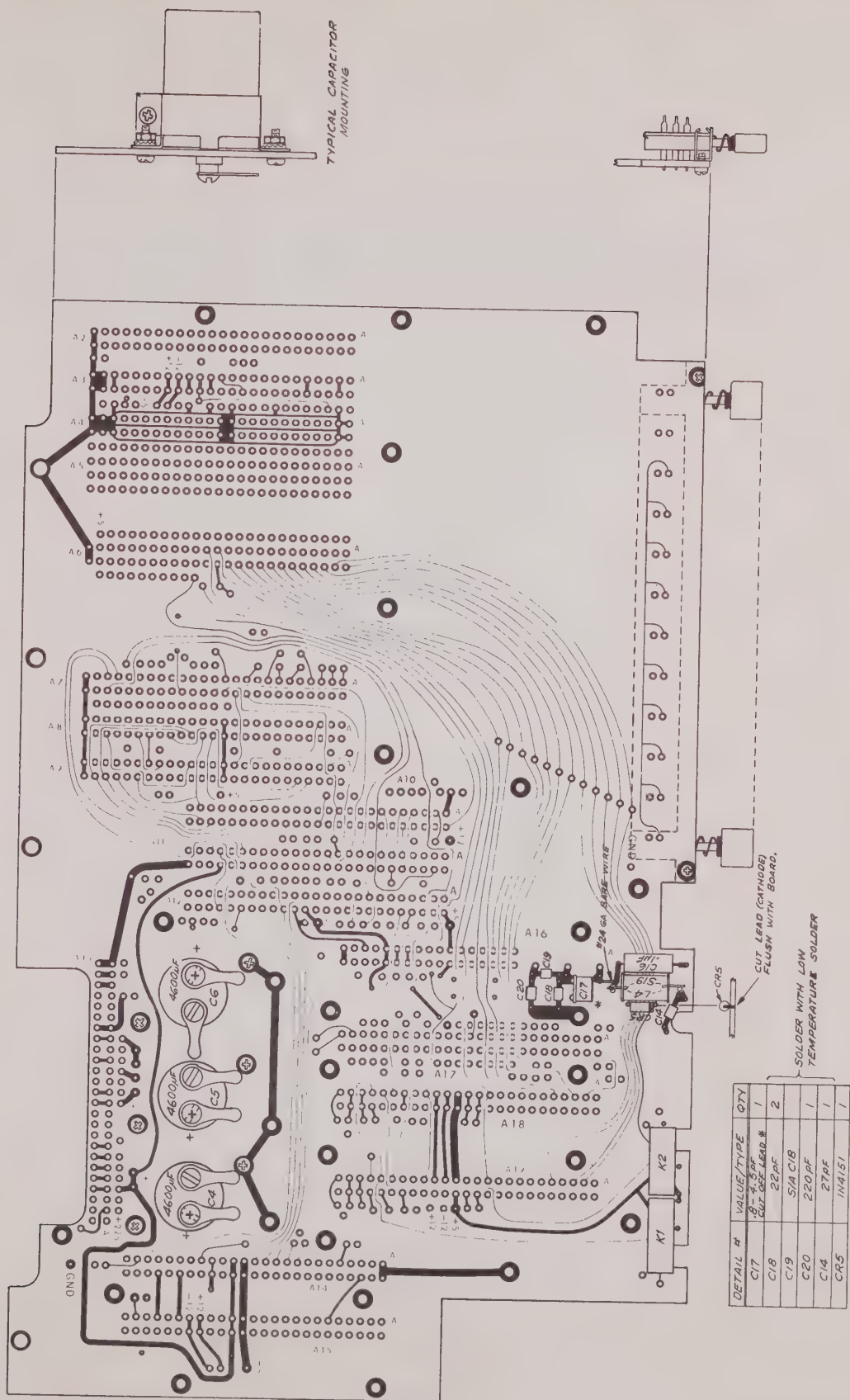


MOULDED  
JUMPER



| DETAIL #           | VALUE/TYPE | QTY |
|--------------------|------------|-----|
| C10, C11, C12, C13 | 4.7µF      | 4   |
| C15                | .001µF     | 1   |
| CR3, CR4           | 1N4151     | 2   |
| L3                 | .06µH      | 1   |
| R4                 | 22Ω, 1/4W  | 1   |
| R5                 | 100Ω, 1/4W | 1   |
| R7                 | 910K, 1/4W | 1   |
| R8                 | 200K, 1/4W | 1   |
| R9                 | 20K, 1/4W  | 1   |
| R10                | 180K, 1/4W | 1   |
| R13                | 97Ω, 1/4W  | 1   |

MOTHER BOARD P.C. ASSEMBLY #C39114E (Sheet 1 of 2)





## CHAPTER 8 OPTIONS

### 8.1 INTRODUCTION

This chapter contains the option descriptions added to the standard Model 6150-50. Each option is described in a separate package and identified with the option title and number at the bottom of the page.





OPTION 01  
DIGITAL OUTPUTS  
(BCD, POSITIVE TRUE +5 V)

DESCRIPTION

This assembly provides a means of interconnecting BCD, option 01, information from the Readout, A1, storage to the BCD output connector J12. A 5 k $\Omega$  pullup resistor A1A2, U1-U10 is provided for each BCD line. Positive true logic is employed; however, to inhibit the automatic reset, a closure to ground is required. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 k $\Omega$  resistor to be compatible with certain printers.

SPECIFICATIONS

Output: Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units.  
"1" state (true): >+3.5 V  
"0" state (false): <+0.8 V

Impedance: TTL output

Reference Positive reference = +5 V through 1 k $\Omega$   
Levels: Negative reference = ground

Print +12 V to 0 V step (negative print command) and 0 V  
Command: to +12 V (positive print command) with 1 k $\Omega$  source, dc coupled.

Hold Off >0 V to +0.8 V to inhibit instrument; >+1.8 V to  
Require- enable.  
ment:

Connector: Amphenol 50-pin, P.N 57-30500-375, A1A2, J1

BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

DRAWINGS

Option 01, A1A2, BCD Output P.C. Assembly #B39379  
Option 01, A1A2, BCD Output P.C. Schematic #C39376  
Option 01, A1A2, BCD Output P.C. Assembly Parts List #P/L39379

# BCD OUTPUT PIN ASSIGNMENTS

| NUMERICAL INDICATION<br>on COUNTER | BCD | PIN |
|------------------------------------|-----|-----|
| $10^0$                             | 1   | 1   |
|                                    | 2   | 2   |
|                                    | 4   | 26  |
|                                    | 8   | 27  |
| $10^1$                             | 1   | 3   |
|                                    | 2   | 4   |
|                                    | 4   | 28  |
|                                    | 8   | 29  |
| $10^2$                             | 1   | 5   |
|                                    | 2   | 6   |
|                                    | 4   | 30  |
|                                    | 8   | 31  |
| $10^3$                             | 1   | 7   |
|                                    | 2   | 8   |
|                                    | 4   | 32  |
|                                    | 8   | 33  |
| $10^4$                             | 1   | 9   |
|                                    | 2   | 10  |
|                                    | 4   | 34  |
|                                    | 8   | 35  |
| $10^5$                             | 1   | 11  |
|                                    | 2   | 12  |
|                                    | 4   | 36  |
|                                    | 8   | 37  |
| $10^6$                             | 1   | 13  |
|                                    | 2   | 14  |
|                                    | 4   | 38  |
|                                    | 8   | 39  |
| $10^7$                             | 1   | 15  |
|                                    | 2   | 16  |
|                                    | 4   | 40  |
|                                    | 8   | 41  |

## ANNUNCIATOR

|   |          |
|---|----------|
| 1 | 17       |
| 2 | 18       |
| 4 | 42       |
| 8 | (Gnd) 43 |

## ANNUNCIATOR TRANSLATIONS

## Measurement:

|     |            |
|-----|------------|
| *   | = Binary 0 |
| MHz | = Binary 1 |
| KHz | = Binary 2 |
| sec | = Binary 3 |
| ms  | = Binary 4 |
| μs  | = Binary 5 |

## DECIMAL POINT

|   |    |
|---|----|
| 1 | 19 |
| 2 | 20 |
| 4 | 44 |
| 8 | 45 |

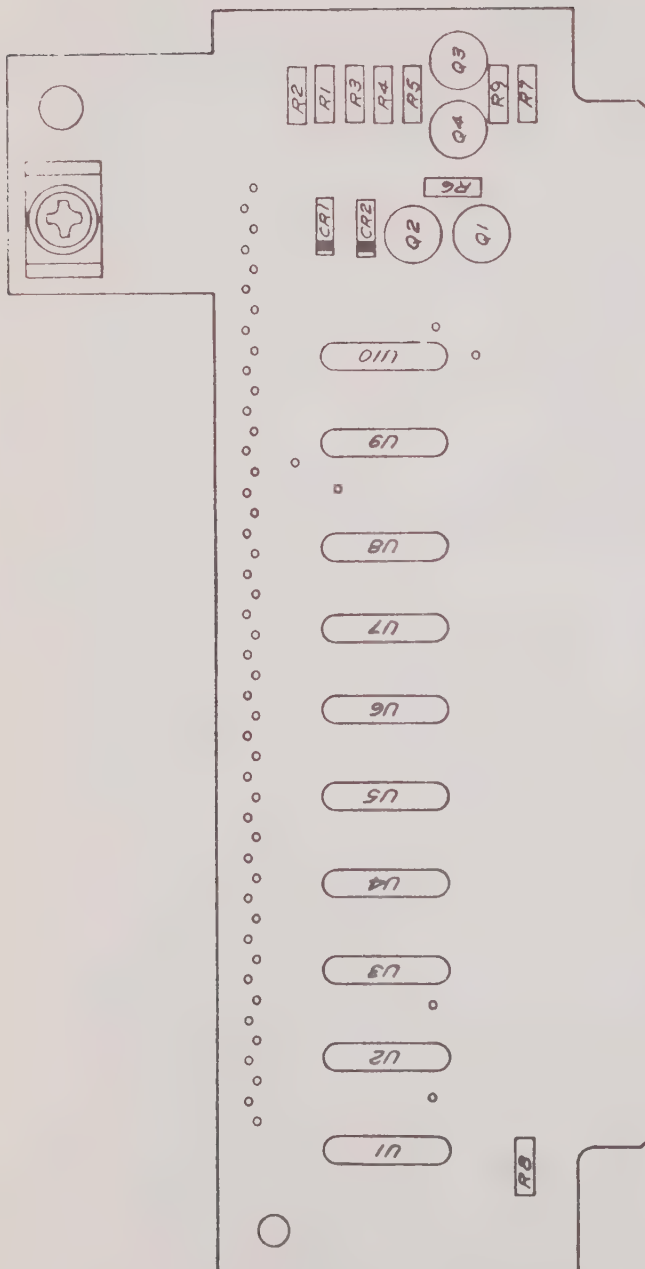
## DECIMAL TRANSLATION

## Readout Location

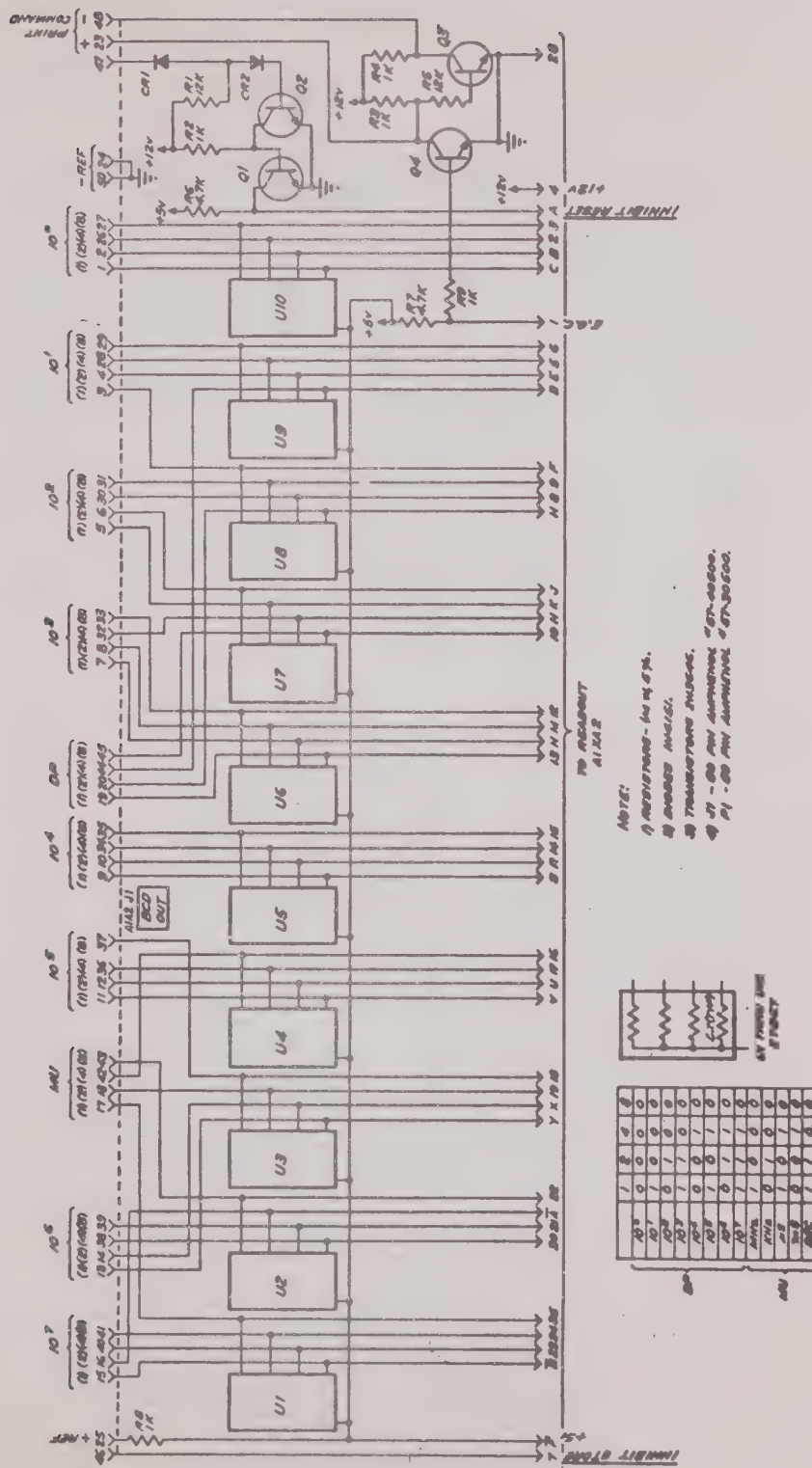
|        |            |
|--------|------------|
| $10^0$ | = Binary 0 |
| $10^1$ | = Binary 1 |
| $10^2$ | = Binary 2 |
| $10^3$ | = Binary 3 |
| $10^4$ | = Binary 4 |
| $10^5$ | = Binary 5 |
| $10^6$ | = Binary 6 |
| $10^7$ | = Binary 7 |

## RECORDER CONTROL

|                |    |
|----------------|----|
| + Reference    | 25 |
| -Reference     | 24 |
| Instrument Gnd | 50 |
| +Print Command | 23 |
| Reset Inhibit  | 47 |
| -Print Command | 48 |
| Inhibit Store  | 46 |



OPTION 01, A1A2, BCD OUTPUT P.C. ASSEMBLY #B39379



OPTION 01, A1A2, BCD OUTPUT P.C. SCHEMATIC #C39379



# OPTION 01, A1A2, BCD OUTPUT P.C. ASSEMBLY PARTS LIST

| Ref. | Description                            | SD<br>Part No. |
|------|----------------------------------------|----------------|
| ALA2 | Option 01 BCD Output P.C. Assembly     | B39379         |
| ALA2 | Option 01 BCD Output Schematic         | C39376         |
|      | BCD Output Cable Assembly              | C39712         |
| CR1  | Diode, 1N4151                          | CR0150         |
| CR2  | Diode, 1N4151                          | CR0150         |
| R1   | Resistor, 12 k, 5%, 1/4 W              | R0759          |
| R2   | Resistor, 1 k, 5%, 1/4 W               | R0765          |
| R3   | Resistor, 1 k, 5%, 1/4 W               | R0765          |
| R4   | Resistor, 1 k, 5%, 1/4 W               | R0765          |
| R5   | Resistor, 12 k, 5%, 1/4 W              | R0759          |
| R6   | Resistor, 4.7 k, 5%, 1/4 W             | R0892          |
| R7   | Resistor, 4.7 k, 5%, 1/4 W             | R0892          |
| R8   | Resistor, 1 k, 5%, 1/4 W               | R0765          |
| R9   | Resistor, 1 k, 5%, 1/4 W               | R0765          |
| U1   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U2   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U3   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U4   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U5   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U6   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U7   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U8   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U9   | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
| U10  | Resistor Network, 4 x 5 k, 20%, 1/10 W | 27867          |
|      | Cable Clamp                            | 37021790       |
|      | Connector                              | J0170          |

OPTION 02  
DIGITAL OUTPUTS  
(BCD, GROUND TRUE, +5 V)

DESCRIPTION

This assembly provides a means of interconnecting BCD, option 02, information from the Readout, A1, storage to the BCD output connector J12. A 12 k $\Omega$  pullup resistor A1A2, U9-U16 is provided for each BCD line. Ground true logic is employed with a closure to ground required to inhibit the automatic reset. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 k $\Omega$  resistor to be compatible with certain printers.

SPECIFICATIONS

Output: Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units.  
"1" state (true): <+0.8 V  
"0" state (false): >+3.5 V

Impedance: TTL output

Reference Levels: High reference = +5 V through 1 k $\Omega$   
Lo reference = ground

Print Command: +12 V to 0 V step (negative print command) and 0 V to +12 V (positive print command) with 1 k $\Omega$  source, dc coupled.

Hold Off Requirement: >0 V to +0.8 V to inhibit instrument; >+1.8 V to enable.

Connector: Amphenol 50-pin, P/N 57-30500-375, A1A2, J1

BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

DRAWINGS

Option 02, A1A2, BCD Output P.C. Assembly #C45059  
Option 02, A1A2, BCD Output Schematic #D45022  
Option 02, A1A2, BCD Output P.C. Assembly Parts List #P/L45059

# BCD OUTPUT PIN ASSIGNMENTS

| NUMERICAL INDICATION<br>on COUNTER | BCD | PIN |
|------------------------------------|-----|-----|
| $10^0$                             | 1   | 1   |
|                                    | 2   | 2   |
|                                    | 4   | 26  |
|                                    | 8   | 27  |
| $10^1$                             | 1   | 3   |
|                                    | 2   | 4   |
|                                    | 4   | 28  |
|                                    | 8   | 29  |
| $10^2$                             | 1   | 5   |
|                                    | 2   | 6   |
|                                    | 4   | 30  |
|                                    | 8   | 31  |
| $10^3$                             | 1   | 7   |
|                                    | 2   | 8   |
|                                    | 4   | 32  |
|                                    | 8   | 33  |
| $10^4$                             | 1   | 9   |
|                                    | 2   | 10  |
|                                    | 4   | 34  |
|                                    | 8   | 35  |
| $10^5$                             | 1   | 11  |
|                                    | 2   | 12  |
|                                    | 4   | 36  |
|                                    | 8   | 37  |
| $10^6$                             | 1   | 13  |
|                                    | 2   | 14  |
|                                    | 4   | 38  |
|                                    | 8   | 39  |
| $10^7$                             | 1   | 15  |
|                                    | 2   | 16  |
|                                    | 4   | 40  |
|                                    | 8   | 41  |

|             |   |    |
|-------------|---|----|
| ANNUNCIATOR | 1 | 17 |
|             | 2 | 18 |
|             | 4 | 42 |
|             | 8 | 43 |

#### ANNUNCIATOR TRANSLATIONS

|              |     |            |
|--------------|-----|------------|
| Measurement: | *   | = Binary 0 |
|              | MHz | = Binary 1 |
|              | KHz | = Binary 2 |
|              | sec | = Binary 3 |
|              | ms  | = Binary 4 |
|              | μs  | = Binary 5 |

|               |   |    |
|---------------|---|----|
| DECIMAL POINT | 1 | 19 |
|               | 2 | 20 |
|               | 4 | 44 |
|               | 8 | 45 |

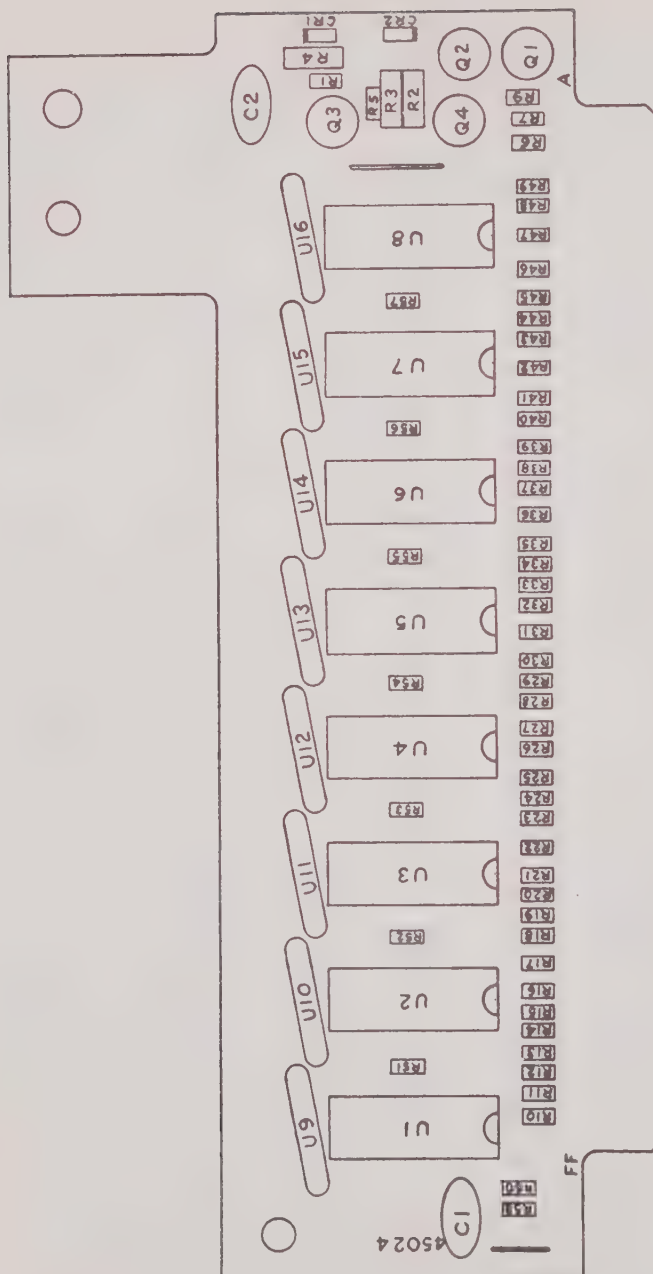
#### DECIMAL TRANSLATION

|                  |        |            |
|------------------|--------|------------|
| Readout Location | $10^0$ | = Binary 0 |
|                  | $10^1$ | = Binary 1 |
|                  | $10^2$ | = Binary 2 |
|                  | $10^3$ | = Binary 3 |
|                  | $10^4$ | = Binary 4 |
|                  | $10^5$ | = Binary 5 |
|                  | $10^6$ | = Binary 6 |
|                  | $10^7$ | = Binary 7 |

#### RECORDER CONTROL

|                |    |
|----------------|----|
| HI Reference   | 25 |
| LO Reference   | 24 |
| Instrument Gnd | 50 |
| Print Command  | 23 |

|                      |    |
|----------------------|----|
| <u>Inhibit Reset</u> | 47 |
| <u>Print Command</u> | 48 |
| Inhibit Store        | 46 |



OPTION 02, A1A2, BCD OUTPUT P.C. ASSEMBLY #C45059





# OPTION 02 FINAL ASSEMBLY PARTS LIST

| Ref.    | Description                                           | SD<br>Part No. |
|---------|-------------------------------------------------------|----------------|
|         | Option 02 Final Assembly                              | C45352         |
|         | <u>ADD</u>                                            |                |
|         | +5V Negative True BCD Output Assembly<br>consists of: | C45351         |
| 4       | +5V Negative True BCD Output P.C. Assembly            | C45059         |
| 5       | Negative True BCD Output Cable Assembly               | C45341         |
| Pl2     | Connector, w/hood, 50 pin                             | J0171          |
|         | * * * * *                                             |                |
|         | +5V Negative True BCD Output P.C. Assembly            | C45049         |
|         | +5V Negative True BCD Output P.C. Schematic           | D45022         |
| C1      | Capacitor, .01 F, 100 V                               | C0556          |
| C2      | Capacitor, .01 F, 100 V                               | C0556          |
| CR1     | Diode, 1N4151                                         | CR0150         |
| CR2     | Diode, 1N4151                                         | CR0150         |
| Q1      | Transistor, 2N3646                                    | Q0218          |
| Q2      | Transistor, 2N3646                                    | Q0218          |
| Q3      | Transistor, 2N3646                                    | Q0218          |
| Q4      | Transistor, 2N3646                                    | Q0218          |
| R1      | Resistor, 12 k, 5%, 1/8 W                             | R2464          |
| R2      | Resistor, 12 k, 5%, 1/4 W                             | R0759          |
| R3      | Resistor, 1 k, 5%, 1/4 W                              | R0765          |
| R4      | Resistor, 1 k, 5%, 1/4 W                              | R0765          |
| R5      | Resistor, 12 k, 5%, 1/8 W                             | R2464          |
| R6      | Resistor, 4.7 k, 5%, 1/8 W                            | R1733          |
| R7      | Resistor, 4.7 k, 5%, 1/8 W                            | R1733          |
| R8      | Not Used                                              |                |
| R9      | Resistor, 1 k, 5%, 1/8 W                              | R1453          |
| R10-R57 | Resistor, 4.7 k, 5%, 1/8 W                            | R1733          |
| R58     | Resistor, 1 k, 5%, 1/8 W                              | R1453          |
| U1      | Integrated Circuit, CA3046                            | 25725          |
| U2      | Integrated Circuit, CA3046                            | 25725          |
| U3      | Integrated Circuit, CA3046                            | 25725          |
| U4      | Integrated Circuit, CA3046                            | 25725          |
| U5      | Integrated Circuit, CA3046                            | 25725          |
| U6      | Integrated Circuit, CA3046                            | 25725          |
| U7      | Integrated Circuit, CA3046                            | 25725          |

# OPTION 02 FINAL ASSEMBLY PARTS LIST (Cont'd)

| Ref.      | Description                       | SD<br>Part No. |
|-----------|-----------------------------------|----------------|
| U8        | Integrated Circuit, CA3046        | 25725          |
| U9        | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U10       | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U11       | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U12       | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U13       | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U14       | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U15       | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U16       | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| * * * * * |                                   |                |
|           | Negative True BCD Cable Assembly  | C45341         |
| J12       | Connector, 50 pin                 | J0170          |



OPTION 03  
DIGITAL OUTPUTS  
(BCD, POSITIVE TRUE +12 V)

DESCRIPTION

This assembly provides a means of interconnecting BCD, option 03, information from the Readout, A1, storage to the BCD output connector J12. A 12 k $\Omega$  pullup resistor A1A2, U9-U24 is provided for each BCD line. Positive true logic is employed; however, to inhibit the automatic reset, a closure to ground is required. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 k $\Omega$  resistor to be compatible with certain printers.

SPECIFICATIONS

Output: Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units.  
          "1" state (true): >10 V  
          "0" state (false): <1 V

Impedance: 12 k $\Omega$  source

Reference Hi reference = +9 V through 3.3 k $\Omega$   
Levels: Lo reference = +3 V

Print +12 V to 0 V step (negative print command) and 0 V  
Command: to +12 V (positive print command) with 1 k $\Omega$  source, dc coupled.

Hold Off >0 V to +0.8 V to inhibit instrument; >+1.8 V to  
Require- enable.  
ment:

Connector: Amphenol 50-pin, P/N 57-30500-375, A1A2, J1

BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

DRAWINGS

Option 03, A1A2, BCD Output P.C. Assembly #B45107  
Option 03, A1A2, BCD Output P.C. Schematic #D45104  
Option 03, A1A2, BCD Output P.C. Assembly Parts List #P/L45107

# BCD OUTPUT PIN ASSIGNMENTS

| NUMERICAL INDICATION<br>on COUNTER | BCD | PIN |
|------------------------------------|-----|-----|
| $10^0$                             | 1   | 1   |
|                                    | 2   | 2   |
|                                    | 4   | 26  |
|                                    | 8   | 27  |
| $10^1$                             | 1   | 3   |
|                                    | 2   | 4   |
|                                    | 4   | 28  |
|                                    | 8   | 29  |
| $10^2$                             | 1   | 5   |
|                                    | 2   | 6   |
|                                    | 4   | 30  |
|                                    | 8   | 31  |
| $10^3$                             | 1   | 7   |
|                                    | 2   | 8   |
|                                    | 4   | 32  |
|                                    | 8   | 33  |
| $10^4$                             | 1   | 9   |
|                                    | 2   | 10  |
|                                    | 4   | 34  |
|                                    | 8   | 35  |
| $10^5$                             | 1   | 11  |
|                                    | 2   | 12  |
|                                    | 4   | 36  |
|                                    | 8   | 37  |
| $10^6$                             | 1   | 13  |
|                                    | 2   | 14  |
|                                    | 4   | 38  |
|                                    | 8   | 39  |
| $10^7$                             | 1   | 15  |
|                                    | 2   | 16  |
|                                    | 4   | 40  |
|                                    | 8   | 41  |

## ANNUNCIATOR

|   |    |
|---|----|
| 1 | 17 |
| 2 | 18 |
| 4 | 42 |
| 8 | 43 |

## ANNUNCIATOR TRANSLATIONS

## Measurement:

|     |            |
|-----|------------|
| *   | = Binary 0 |
| MHz | = Binary 1 |
| KHz | = Binary 2 |
| sec | = Binary 3 |
| ms  | = Binary 4 |
| μs  | = Binary 5 |

## DECIMAL POINT

|   |    |
|---|----|
| 1 | 19 |
| 2 | 20 |
| 4 | 44 |
| 8 | 45 |

## DECIMAL TRANSLATION

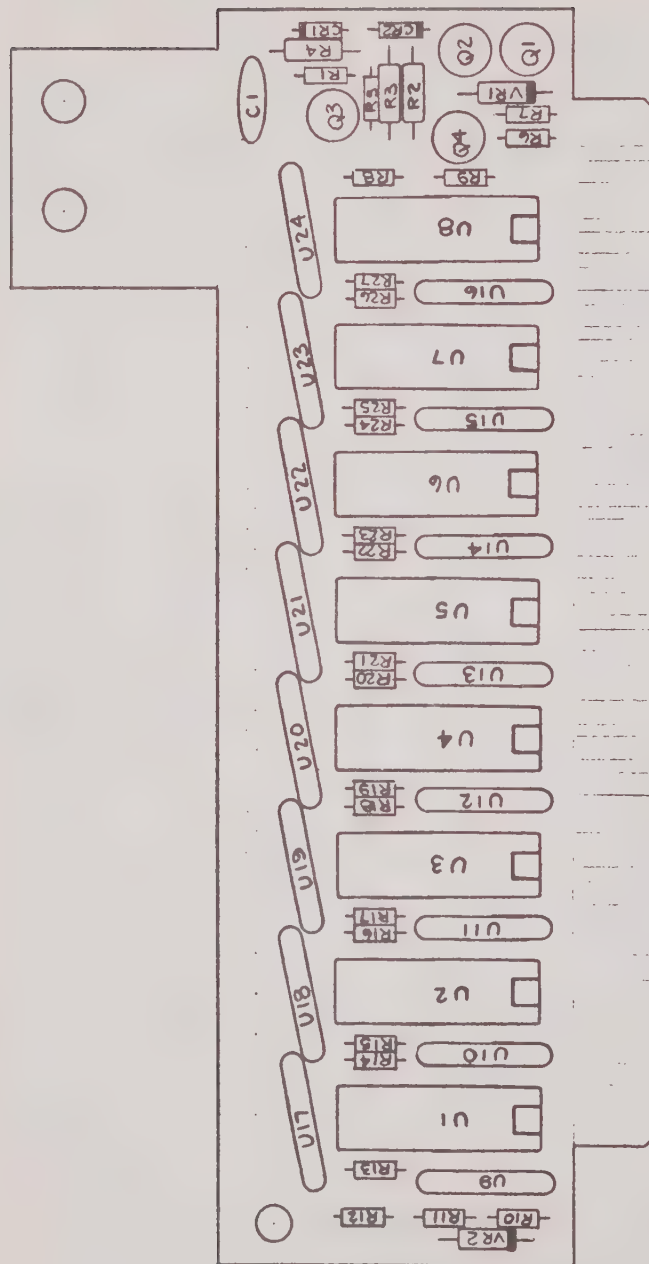
## Readout Location

|        |            |
|--------|------------|
| $10^0$ | = Binary 0 |
| $10^1$ | = Binary 1 |
| $10^2$ | = Binary 2 |
| $10^3$ | = Binary 3 |
| $10^4$ | = Binary 4 |
| $10^5$ | = Binary 5 |
| $10^6$ | = Binary 6 |
| $10^7$ | = Binary 7 |

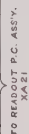
## RECORDER CONTROL

|                      |    |
|----------------------|----|
| Hi Reference         | 25 |
| Lo Reference         | 24 |
| Instrument Gnd       | 50 |
| +Print Command       | 23 |
| <u>Inhibit Reset</u> | 47 |
| -Print Command       | 48 |
| Inhibit Store        | 46 |





OPTION 03, A1A2, BCD OUTPUT P.C. ASSEMBLY #B45107



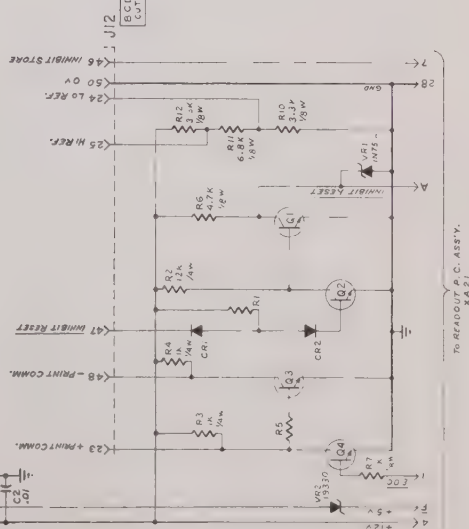
NOTES: (UNLESS SPECIFIED,

1. RESISTORS: 12K,  $\frac{1}{8}$  W, 5%; RI, R2, R3, R4, R5, R6, R7, R8, R9, R12 THRU R27
2. DIODES: IN41E1
3. TRANSISTORS: 2N3640
4. U1 THRU U8: CA3033; PIN 5  $T_0$  AND
5. U12: 50 PIN AMPHENOL #37-40500
6. U13: 50 PIN AMPHENOL #57-3C50



TYPICAL  
U9 THRU U24  
45003

| SYMBOL |    | BINARY CODE |   |   |   |
|--------|----|-------------|---|---|---|
| SYMBOL |    | 8           | 4 | 2 | 1 |
| MU     | MH | 0           | 0 | 0 | 0 |
|        | KH | 0           | 0 | 0 | 1 |
|        | SH | 0           | 0 | 1 | 0 |
|        | MS | 0           | 1 | 0 | 0 |
|        | LS | 0           | 1 | 1 | 0 |
| OP     | TO | 1           | 0 | 0 | 0 |
|        | TS | 1           | 0 | 0 | 1 |
|        | TS | 1           | 0 | 1 | 1 |
|        | TS | 1           | 1 | 0 | 1 |
|        | TS | 1           | 1 | 1 | 0 |



TO READOUT P. C. ASS'Y.  
XA21

# OPTION 03 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                                            | SD<br>Part No. |
|------|--------------------------------------------------------|----------------|
|      | Option 03 Final Assembly                               | C45378         |
|      | <u>ADD</u>                                             |                |
| 4    | +12V Positive True BCD Output Assembly<br>consists of: | C45377         |
| 4    | +12V Positive True BCD Output P.C. Assembly            | B45107         |
| 5    | +12V Positive True BCD Output Cable Assembly           | C45122         |
| P12  | Connector w/hood, 50 pin                               | J0171          |
|      | * * * * *                                              |                |
|      | +12V Positive True BCD Output P.C. Assembly            | B45107         |
|      | +12V Positive True BCD Output P.C. Schematic           | D45104         |
| C1   | Capacitor, .01 $\mu$ F, 100 V                          | C0556          |
| CR1  | Diode, 1N4151                                          | CR0150         |
| CR2  | Diode, 1N4151                                          | CR0150         |
| Q1   | Transistor, 2N3646                                     | Q0218          |
| Q2   | Transistor, 2N3646                                     | Q0218          |
| Q3   | Transistor, 2N3646                                     | Q0218          |
| Q4   | Transistor, 2N3646                                     | Q0218          |
| R1   | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R2   | Resistor, 12 k, 5%, 1/4 W                              | R0759          |
| R3   | Resistor, 1 k, 5%, 1/4 W                               | R0765          |
| R4   | Resistor, 1 k, 5%, 1/4 W                               | R0765          |
| R5   | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R6   | Resistor, 4.7 k, 5%, 1/8 W                             | R1733          |
| R7   | Resistor, 1 k, 5%, 1/8 W                               | R1453          |
| R8   | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R9   | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R10  | Resistor, 3.3 k, 5%, 1/8 W                             | R1456          |
| R11  | Resistor, 6.8 k, 5%, 1/8 W                             | R1459          |
| R12  | Resistor, 3.3 k, 5%, 1/8 W                             | R1456          |
| R13  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R14  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R15  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R16  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R17  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R18  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R19  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R20  | Resistor, 12 k, 5%, 1/8 W                              | R2464          |

# OPTION 03 FINAL ASSEMBLY PARTS LIST (Cont'd)

| Ref. | Description                    | SD<br>Part No. |
|------|--------------------------------|----------------|
| R21  | Resistor, 12 k, 5%, 1/8 W      | R2464          |
| R22  | Resistor, 12 k, 5%, 1/8 W      | R2464          |
| R23  | Resistor, 12 k, 5%, 1/8 W      | R2464          |
| R24  | Resistor, 12 k, 5%, 1/8 W      | R2464          |
| R25  | Resistor, 12 k, 5%, 1/8 W      | R2464          |
| R26  | Resistor, 12 k, 5%, 1/8 W      | R2464          |
| R27  | Resistor, 12 k, 5%, 1/8 W      | R2464          |
| U1   | Integrated Circuit, CA3083     | 25790          |
| U2   | Integrated Circuit, CA3083     | 25790          |
| U3   | Integrated Circuit, CA3083     | 25790          |
| U4   | Integrated Circuit, CA3083     | 25790          |
| U5   | Integrated Circuit, CA3083     | 25790          |
| U6   | Integrated Circuit, CA3083     | 25790          |
| U7   | Integrated Circuit, CA3083     | 25790          |
| U8   | Integrated Circuit, CA3083     | 25790          |
| U9   | Resistor Network, 12 k, 1/10 W | 45008          |
| U10  | Resistor Network, 12 k, 1/10 W | 45008          |
| U11  | Resistor Network, 12 k, 1/10 W | 45008          |
| U12  | Resistor Network, 12 k, 1/10 W | 45008          |
| U13  | Resistor Network, 12 k, 1/10 W | 45008          |
| U14  | Resistor Network, 12 k, 1/10 W | 45008          |
| U15  | Resistor Network, 12 k, 1/10 W | 45008          |
| U16  | Resistor Network, 12 k, 1/10 W | 45008          |
| U17  | Resistor Network, 12 k, 1/10 W | 45008          |
| U18  | Resistor Network, 12 k, 1/10 W | 45008          |
| U19  | Resistor Network, 12 k, 1/10 W | 45008          |
| U20  | Resistor Network, 12 k, 1/10 W | 45008          |
| U21  | Resistor Network, 12 k, 1/10 W | 45008          |
| U22  | Resistor Network, 12 k, 1/10 W | 45008          |
| U23  | Resistor Network, 12 k, 1/10 W | 45008          |
| U24  | Resistor Network, 12 k, 1/10 W | 45008          |
| VR1  | Diode, Breakdown 1N751A        | CR0095         |
| VR2  | Diode, Breakdown 19330         | 19330          |

\* \* \* \* \*

|     |                                                                   |                 |
|-----|-------------------------------------------------------------------|-----------------|
| J12 | +12V Positive True BCD Output Cable Assembly<br>Connector, 50 pin | C45122<br>J0170 |
|-----|-------------------------------------------------------------------|-----------------|



OPTION 04  
DIGITAL OUTPUTS  
(BCD, GROUND TRUE +12 V)

## DESCRIPTION

This assembly provides a means of interconnecting BCD, option 04, information from the Readout, A1, storage to the BCD output connector J12. A 12 k $\Omega$  pullup resistor A1A2, U9-U16 is provided for each BCD line. Ground true logic is employed with a closure to ground required to inhibit the automatic reset. The EOC (end-of-count) or Print Command is either a positive going (pin 23) or a negative going (pin 48) signal output. These print command signals are from a +12 V source through a 1 k $\Omega$  resistor to be compatible with certain printers.

## SPECIFICATIONS

Output: Four line BCD (1-2-4-8), all indicators, decimal points, and measurement units.  
"1" state (true): +.5 V, 5 mA sink  
"0" state (false): +12 V

Impedance: "0" = 12 k $\Omega$  **source** and "1" = 5 mA sink

Reference Levels: Hi reference = +9 V through 3.3 k $\Omega$   
Lo reference = 3 V

Print Command: +12 V to 0 V step (negative print command) and 0 V to +12 V (positive print command) with 1 k $\Omega$  source, dc coupled.

Hold Off Require-ment:  $\geq 0$  V to +0.8 V to inhibit instrument;  $> +1.8$  V to enable.

Connector: Amphenol 50-pin, P/N 57-30500-375, A1A2, J1

## BCD OUTPUT PIN ASSIGNMENTS

(See following pages)

## DRAWINGS

Option 04, A1A2, BCD Output P.C. Assembly #C45025  
Option 04, A1A2, BCD Output P.C. Schematic #D45021  
Option 04, A1A2, BCD Output P.C. Assembly Parts List #P/L45025



# BCD OUTPUT PIN ASSIGNMENTS

| NUMERICAL INDICATION<br>on COUNTER | BCD | PIN |
|------------------------------------|-----|-----|
| $10^0$                             | 1   | 1   |
|                                    | 2   | 2   |
|                                    | 4   | 26  |
|                                    | 8   | 27  |
| $10^1$                             | 1   | 3   |
|                                    | 2   | 4   |
|                                    | 4   | 28  |
|                                    | 8   | 29  |
| $10^2$                             | 1   | 5   |
|                                    | 2   | 6   |
|                                    | 4   | 30  |
|                                    | 8   | 31  |
| $10^3$                             | 1   | 7   |
|                                    | 2   | 8   |
|                                    | 4   | 32  |
|                                    | 8   | 33  |
| $10^4$                             | 1   | 9   |
|                                    | 2   | 10  |
|                                    | 4   | 34  |
|                                    | 8   | 35  |
| $10^5$                             | 1   | 11  |
|                                    | 2   | 12  |
|                                    | 4   | 36  |
|                                    | 8   | 37  |
| $10^6$                             | 1   | 13  |
|                                    | 2   | 14  |
|                                    | 4   | 38  |
|                                    | 8   | 39  |
| $10^7$                             | 1   | 15  |
|                                    | 2   | 16  |
|                                    | 4   | 40  |
|                                    | 8   | 41  |

|             |   |    |
|-------------|---|----|
| ANNUNCIATOR | 1 | 17 |
|             | 2 | 18 |
|             | 4 | 42 |
|             | 8 | 43 |

#### ANNUNCIATOR TRANSLATIONS

|              |     |            |
|--------------|-----|------------|
| Measurement: | *   | = Binary 0 |
|              | MHz | = Binary 1 |
|              | KHz | = Binary 2 |
|              | sec | = Binary 3 |
|              | ms  | = Binary 4 |
|              | μs  | = Binary 5 |

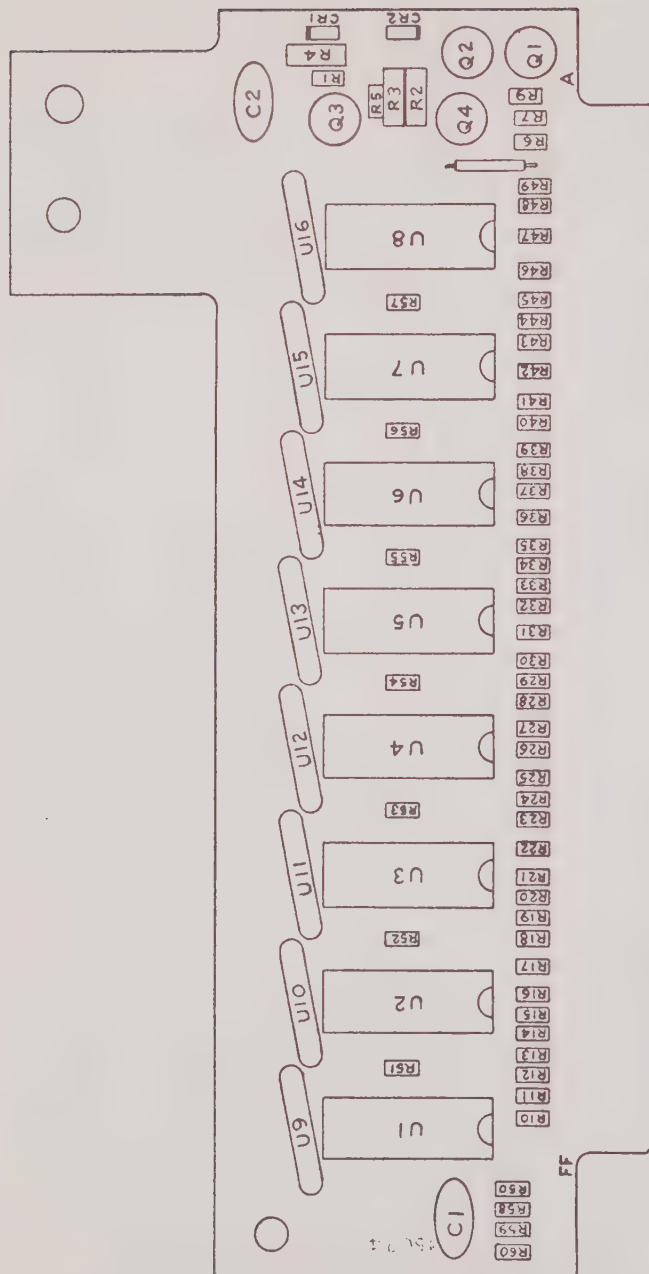
|               |   |    |
|---------------|---|----|
| DECIMAL POINT | 1 | 19 |
|               | 2 | 20 |
|               | 4 | 44 |
|               | 8 | 45 |

#### DECIMAL TRANSLATION

|                  |        |            |
|------------------|--------|------------|
| Readout Location | $10^0$ | = Binary 0 |
|                  | $10^1$ | = Binary 1 |
|                  | $10^2$ | = Binary 2 |
|                  | $10^3$ | = Binary 3 |
|                  | $10^4$ | = Binary 4 |
|                  | $10^5$ | = Binary 5 |
|                  | $10^6$ | = Binary 6 |
|                  | $10^7$ | = Binary 7 |

#### RECORDER CONTROL

|                      |    |
|----------------------|----|
| HI Reference         | 25 |
| LO Reference         | 24 |
| Instrument Gnd       | 50 |
| Print Command        | 23 |
| <u>Inhibit Reset</u> | 47 |
| <u>Print Command</u> | 48 |
| Inhibit Store        | 46 |





# OPTION 04 FINAL ASSEMBLY PARTS LIST

| Ref.      | Description                                            | SD<br>Part No. |
|-----------|--------------------------------------------------------|----------------|
|           | Option 04 Final Assembly                               | C45359         |
|           | <u>ADD</u>                                             |                |
|           | +12V Negative True BCD Output Assembly<br>consists of: | C45358         |
| 4         | +12V Negative True BCD Output P.C. Assembly            | C45025         |
| 5         | Negative True BCD Output Cable Assembly                | C45341         |
| P12       | Connector, w/hood 50 pin                               | J0171          |
| * * * * * |                                                        |                |
|           | +12V Negative True BCD Output P.C. Assembly            | C45025         |
|           | +12V Negative True BCD Output P.C. Schematic           | D45021         |
| C1        | Capacitor, .01 $\mu$ F, 100 V                          | C0556          |
| C2        | Capacitor, .01 $\mu$ F, 100 V                          | C0556          |
| CR1       | Diode, 1N4151                                          | CR0150         |
| CR2       | Diode, 1N4151                                          | CR0150         |
| Q1        | Transistor, 2N3646                                     | Q0218          |
| Q2        | Transistor, 2N3646                                     | Q0218          |
| Q3        | Transistor, 2N3646                                     | Q0218          |
| Q4        | Transistor, 2N3646                                     | Q0218          |
| R1        | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R2        | Resistor, 12 k, 5%, 1/4 W                              | R0759          |
| R3        | Resistor, 1 k, 5%, 1/4 W                               | R0765          |
| R4        | Resistor, 1 k, 5%, 1/4 W                               | R0765          |
| R5        | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R6        | Resistor, 4.7 k, 5%, 1/8 W                             | R1733          |
| R7        | Resistor, 4.7 k, 5%, 1/8 W                             | R1733          |
| R8        | Not Used                                               |                |
| R9        | Resistor, 1 k, 5%, 1/8 W                               | R1453          |
| R10-R49   | Resistor, 4.7 k, 5%, 1/8 W                             | R1733          |
| R50       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R51       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R52       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R53       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R54       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R55       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R56       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |
| R57       | Resistor, 12 k, 5%, 1/8 W                              | R2464          |

# OPTION 04 FINAL ASSEMBLY PARTS LIST

| Ref.      | Description                                           | SD<br>Part No.  |
|-----------|-------------------------------------------------------|-----------------|
| R58       | Resistor, 3.3 k, 5%, 1/8 W                            | R1456           |
| R59       | Resistor, 6.8 k, 5%, 1/8 W                            | R1459           |
| R60       | Resistor, 3.3 k, 5%, 1/8 W                            | R1456           |
| U1        | Integrated Circuit, CA3046                            | 25725           |
| U2        | Integrated Circuit, CA3046                            | 25725           |
| U3        | Integrated Circuit, CA3046                            | 25725           |
| U4        | Integrated Circuit, CA3046                            | 25725           |
| U5        | Integrated Circuit, CA3046                            | 25725           |
| U6        | Integrated Circuit, CA3046                            | 25725           |
| U7        | Integrated Circuit, CA3046                            | 25725           |
| U8        | Integrated Circuit, CA3046                            | 25725           |
| U9        | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| U10       | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| U11       | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| U12       | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| U13       | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| U14       | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| U15       | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| U16       | Resistor Network, 4 x 12 k, 1/10 W                    | 45008           |
| * * * * * |                                                       |                 |
| J12       | Negative True BCD Cable Assembly<br>Connector, 50 pin | C45341<br>J0170 |





## OPTION 10 OSCILLATOR

### DESCRIPTION

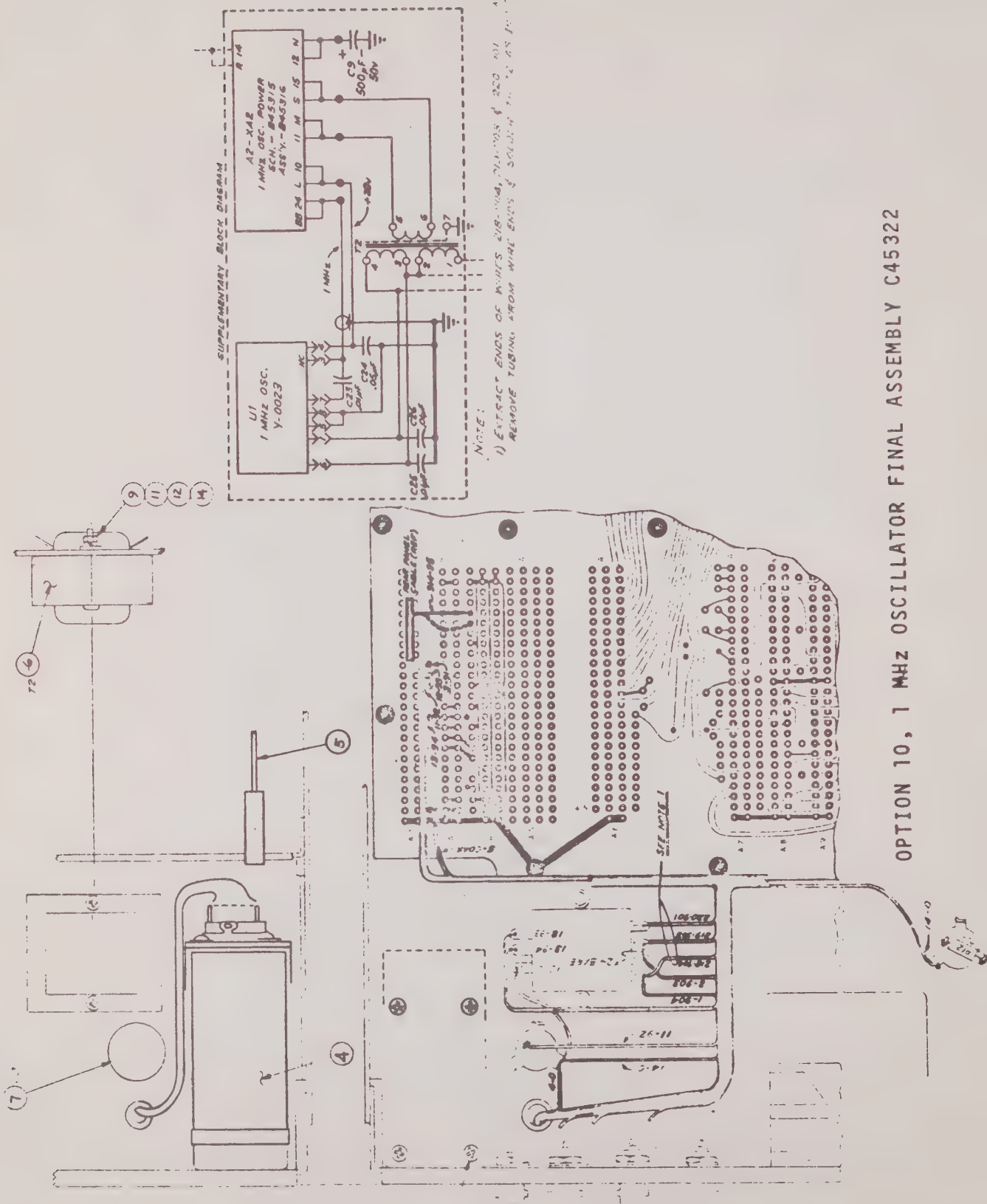
This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 1 MHz oscillator and A2, 1 MHz Oscillator Power Supply.

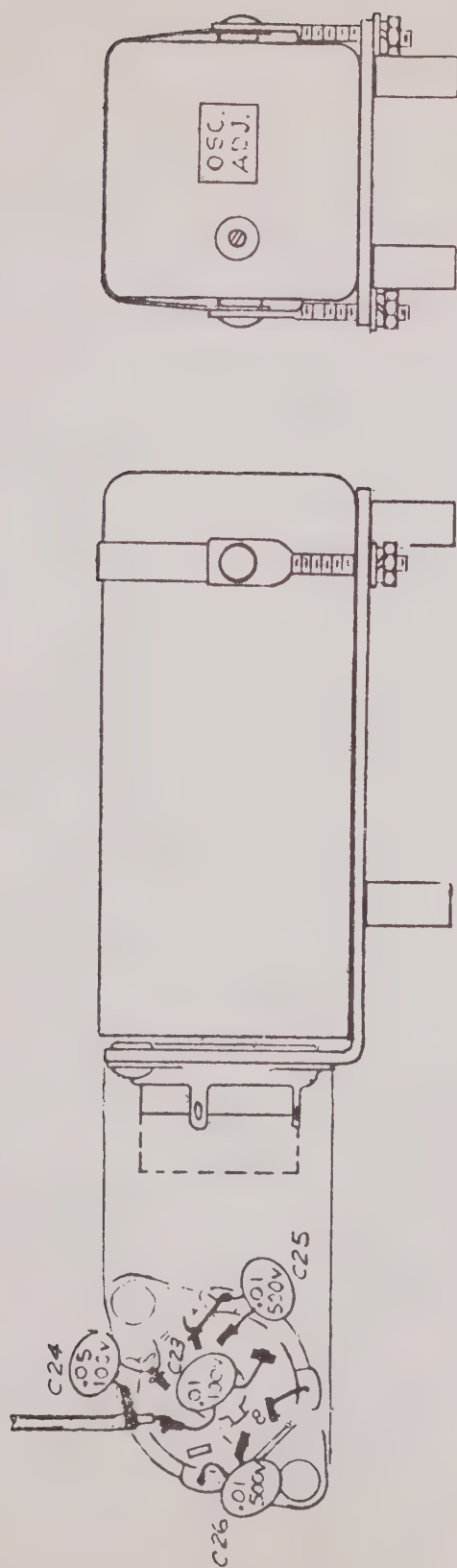
### SPECIFICATIONS

|                                                            |                                                                     |
|------------------------------------------------------------|---------------------------------------------------------------------|
| Aging rate after warm-up:                                  | $\pm 7$ parts $10^9/24$ hrs.<br>$\pm 2$ parts $10^8/24$ hrs.        |
| Maximum warm-up for "OFF" periods to 1 week:               | $\frac{30 \text{ days}}{72 \text{ hrs.}}$                           |
| Frequency retrace for "OFF" periods up to approx. 24 hrs.: | 72 hrs. typical to reach $\pm 2$ parts $10^8$ .                     |
| Short-term aging rate:                                     | $\pm 5$ parts $10^9$ rms for 10 sec average.                        |
| Temperature variation:                                     | $\pm 5$ parts $10^9/^\circ\text{C}$<br>- 20 to $50^\circ\text{C}$ . |
| $\pm 10\%$ change in line voltage from specified:          | $< \pm 2$ parts $10^8$ .                                            |
| Long-term aging rate:                                      | $\pm 3$ parts $10^9/24$ hrs.<br>after 45 days dynamic.              |

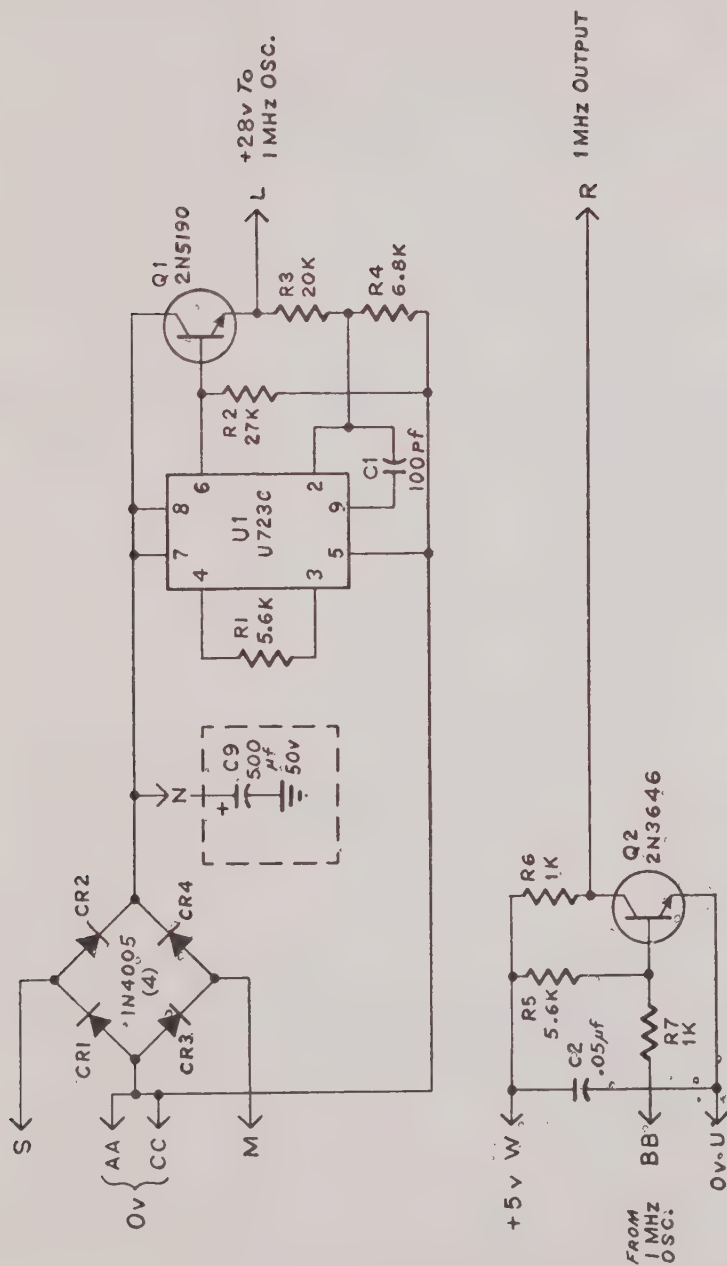
### DRAWINGS

Option 10, 1 MHz Oscillator Final Assembly #C45322  
Option 10, 1 MHz Oscillator Mtg. Bracket Assembly #B39161  
Option 10, 1 MHz Oscillator Power Supply P.C. Assembly #B45316  
Option 10, 1 MHz Oscillator Power Supply Schematic #B45315  
Option 10, 1 MHz Oscillator Final Assembly Parts List #P/L45322









NOTES: (UNLESS NOTED)

1. ALL RESISTORS: 1/4 W, 5 %



# OPTION 10 OSCILLATOR FINAL ASSEMBLY PARTS LIST

| Ref. | Description                           | SD<br>Part No. |
|------|---------------------------------------|----------------|
|      | Oscillator Option 10 Final Assembly   | C45322         |
|      | <u>ADD</u>                            |                |
| 4    | Oscillator Mounting Bracket Assembly  | 39161          |
| A2   | 1 MHz Oscillator Power P.C. Assembly  | B45316         |
| T2   | Transformer                           | B19805         |
| C9   | Capacitor, 500 $\mu$ F, 50 V          | 03286060       |
|      | * * * * *                             |                |
|      | Oscillator Mounting Bracket Assembly  | B39161         |
| 4    | Oscillator Mounting Bracket           | B39160         |
| 5    | Oscillator Clamp Assembly             | B39251         |
| C23  | Capacitor, .01 $\mu$ F, 100 V         | C0556          |
| C24  | Capacitor, .05 $\mu$ F, 100 V         | C0708          |
| C25  | Capacitor, .01 $\mu$ F, 500 V         | C0423          |
| C26  | Capacitor, .01 $\mu$ F, 500 V         | C0423          |
| U1   | Oscillator                            | Y0023          |
|      | * * * * *                             |                |
|      | 1 MHz Oscillator Power P.C. Assembly  | B45316         |
|      | 1 MHz Oscillator Power P.C. Schematic | B45315         |
| C1   | Capacitor, 100 pF, 5%, 500 V          | C0536          |
| C2   | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| CR1  | Diode, 1N4005, 500 V, 1 A             | CR0284         |
| CR2  | Diode, 1N4005, 500 V, 1 A             | CR0284         |
| CR3  | Diode, 1N4005, 500 V, 1 A             | CR0284         |
| CR4  | Diode, 1N4005, 500 V, 1 A             | CR0284         |
| Q1   | Transistor, 2N5190                    | Q0281          |
| Q2   | Transistor, 2N3646                    | Q0218          |
| R1   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R2   | Resistor, 27 k, 5%, 1/4 W             | R0824          |
| R3   | Resistor, 20 k, 5%, 1/4 W             | R0964          |
| R4   | Resistor, 6.8 k, 5%, 1/4 W            | R0696          |
| R5   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R6   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| R7   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| U1   | Integrated Circuit, U723C             | 25756          |

## OPTION 11 OSCILLATOR

### DESCRIPTION

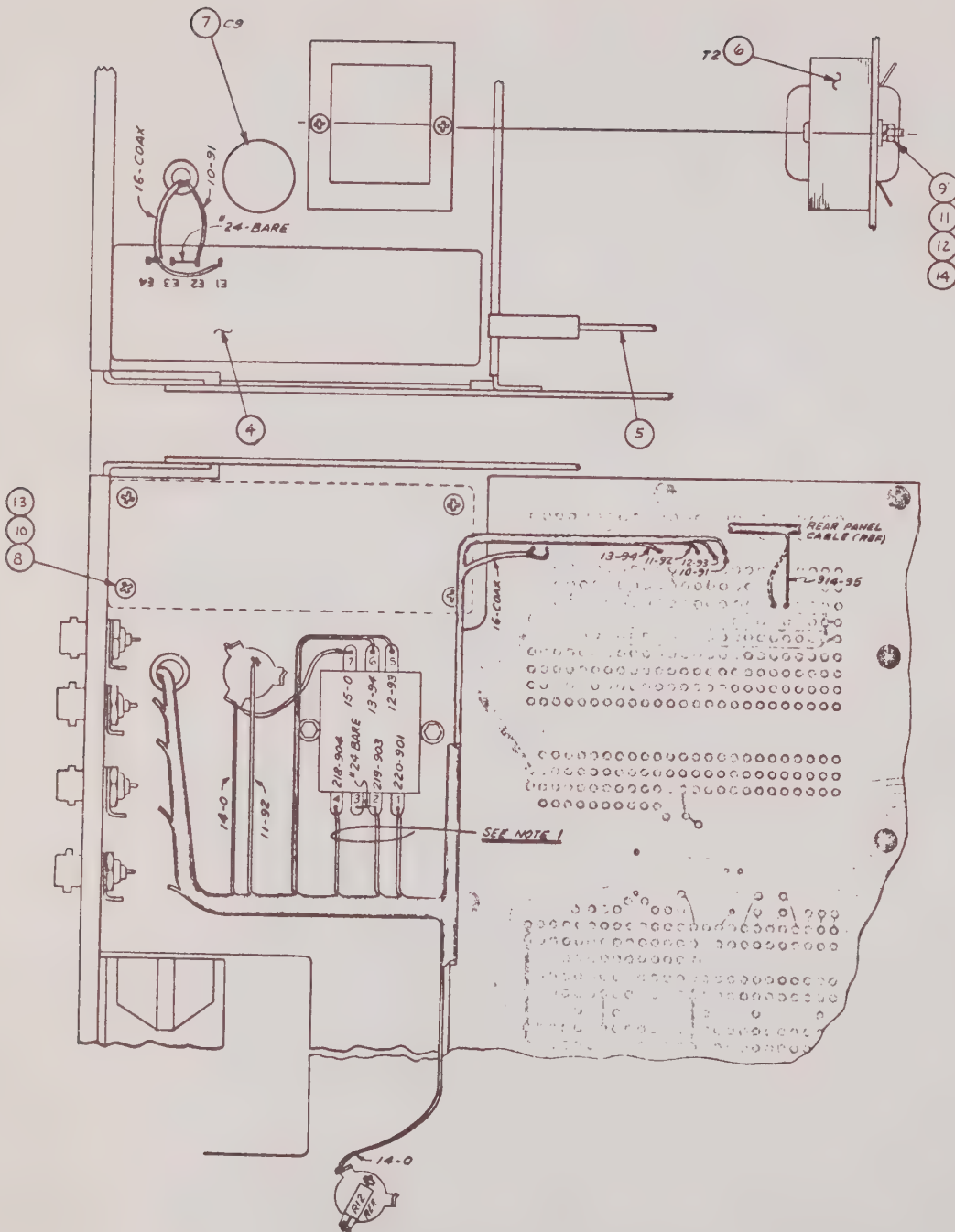
This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 3 MHz Oscillator and A2, 3 MHz Oscillator Power Supply.

### SPECIFICATIONS

|                                                            |                                                                                                                                        |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Aging rate after warm-up:                                  | $\pm 3$ parts $10^9$ /24 hrs.                                                                                                          |
| Maximum warm-up for "OFF" periods to 1 week:               | 72 hrs.                                                                                                                                |
| Frequency retrace for "OFF" periods up to approx. 24 hrs.: | 1 hr. typical to reach $\pm 6$ parts $10^8$ maximum.                                                                                   |
| Short-term aging rate:                                     | $\pm 1$ part $10^{10}$ rms for 1 sec average.                                                                                          |
| Temperature variation:                                     | $< \pm 2$ parts $10^{10}/C^\circ$ , typical (max. $\pm 4$ parts in $10^9$ over $20^\circ$ change within $-20^\circ$ to $50^\circ C$ ). |
| $\pm 10\%$ change in line voltage from specified:          | $\pm 5$ parts $10^{10}$ .                                                                                                              |
| Long-term aging rate:                                      | $\pm 3$ parts $10^8$ /30 days.                                                                                                         |

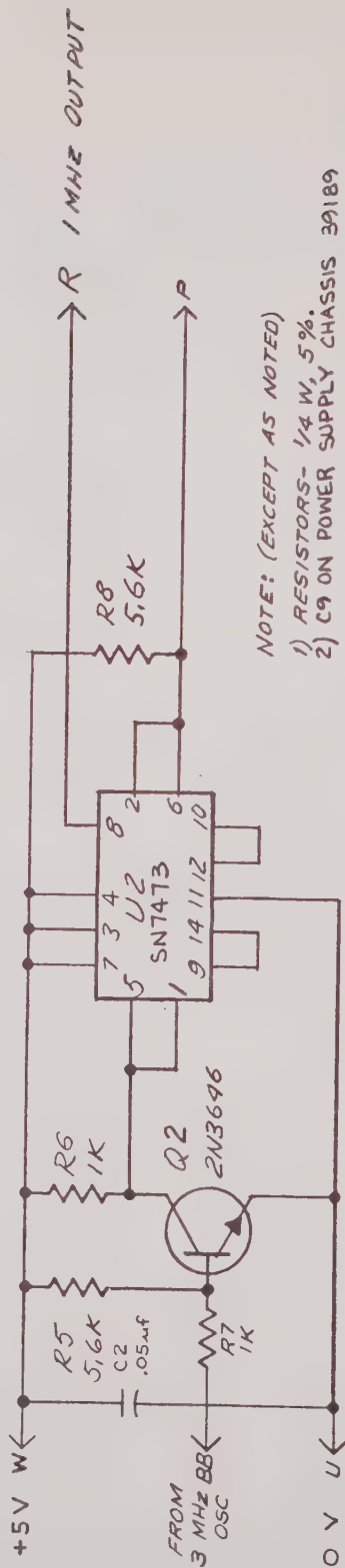
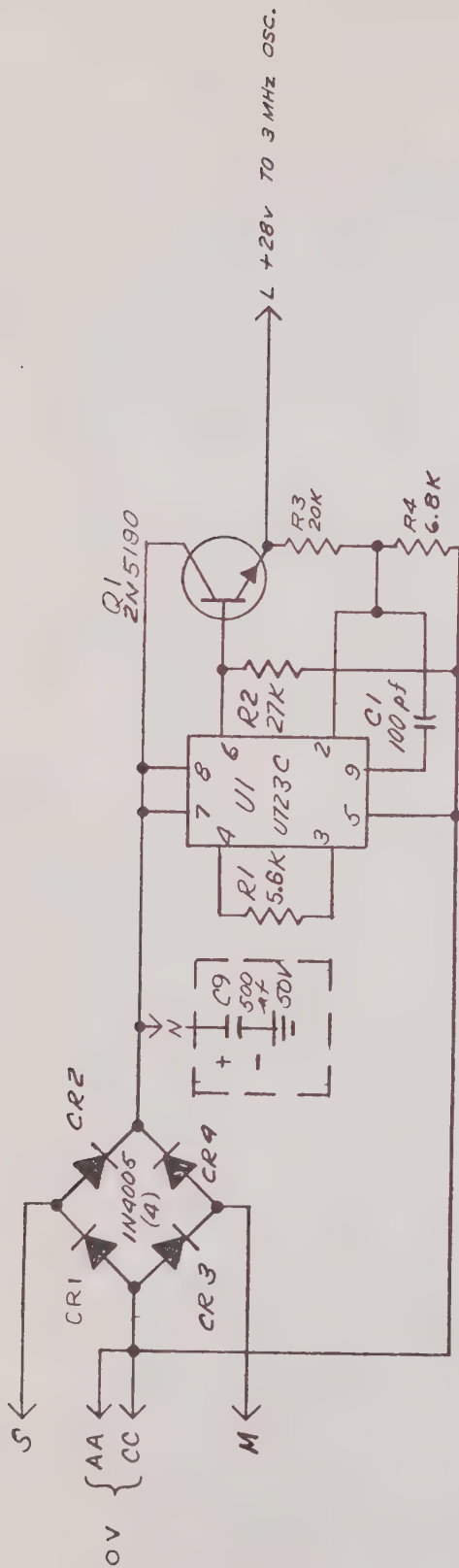
### DRAWINGS

Option 11, 3 MHz Oscillator Final Assembly #C45319  
Option 11, 3 MHz Oscillator Power Supply P.C. Assembly #B39367  
Option 11, 3 MHz Oscillator Power Supply Schematic #B39364  
Option 11, 3 MHz Oscillator Final Assembly Parts List #P/L45319



OPTION 11, 3 MHz OSCILLATOR FINAL ASSEMBLY C45319





NOTE: (EXCEPT AS NOTED)

- 1) RESISTORS- 1/4 W, 5%.
- 2) C9 ON POWER SUPPLY CHASSIS 39189

# OPTION 11 OSCILLATOR FINAL ASSEMBLY PARTS LIST

| Ref. | Description                              | SD<br>Part No. |
|------|------------------------------------------|----------------|
|      | Option 11 Oscillator Final Assembly      | C45319         |
|      | <u>ADD</u>                               |                |
| A2   | See 3 MHz Oscillator Power P.C. Assembly | B39367         |
| C9   | Capacitor, 500 $\mu$ F, 500 V            | 03286060       |
| T2   | Transformer                              | B19805         |
| U1   | Oscillator                               | C33428         |

\* \* \* \* \*

## 3 MHz OSCILLATOR POWER P.C. ASSEMBLY

| Ref. | Description                           | SD<br>Part No. |
|------|---------------------------------------|----------------|
|      | 3 MHz Oscillator Power P.C. Assembly  | B39367         |
|      | 3 MHz Oscillator Power P.C. Schematic | B39364         |
| C1   | Capacitor, 100 pF, 5%, 500 V          | C0536          |
| C2   | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| CR1  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR2  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR3  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR4  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| Q1   | Transistor, 2N5190                    | Q0281          |
| Q2   | Transistor, 2N3646                    | Q0218          |
| R1   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R2   | Resistor, 27 k, 5%, 1/4 W             | R0824          |
| R3   | Resistor, 20 k, 5%, 1/4 W             | R0964          |
| R4   | Resistor, 6.8 k, 5%, 1/4 W            | R0696          |
| R5   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R6   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| R7   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| R8   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| U1   | Integrated Circuit, U723C             | 25756          |
| U2   | Integrated Circuit, 7473N             | 19709          |





## OPTION 12 OSCILLATOR

### DESCRIPTION

This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 3 MHz Oscillator and A2, 3 MHz Oscillator Power Supply.

### SPECIFICATIONS

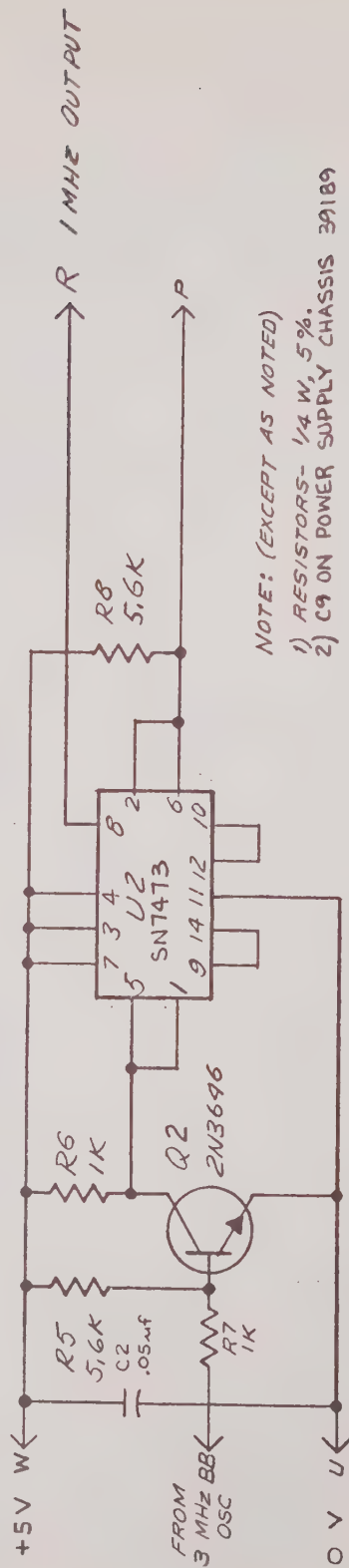
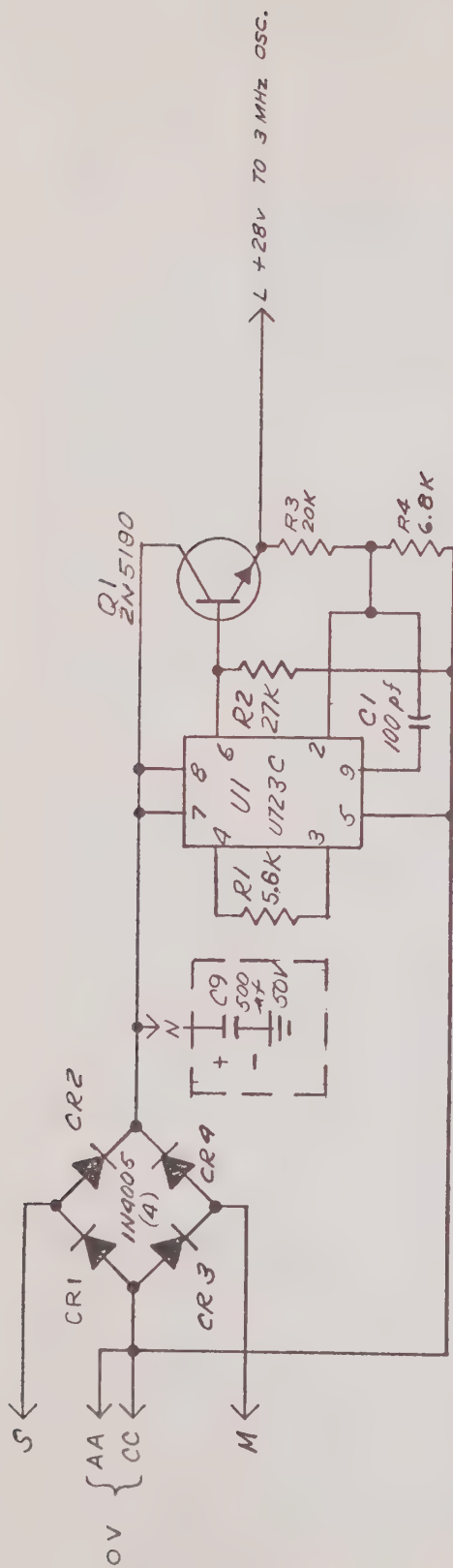
|                                                            |                                                                                                                                                               |
|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Aging rate after warm-up:                                  | $<\pm 1 \text{ part } 10^9/24 \text{ hrs.}$                                                                                                                   |
| Maximum warm-up for "OFF" periods to 1 week:               | 72 hrs.                                                                                                                                                       |
| Frequency retrace for "OFF" periods up to approx. 24 hrs.: | 1 hr. typical to reach $\pm 6 \text{ parts } 10^8$ maximum.                                                                                                   |
| Short-term aging rate:                                     | $\pm 1 \text{ part } 10^{10}$ rms for 1 sec average.                                                                                                          |
| Temperature variation:                                     | $<\pm 2 \text{ parts } 10^{10}/\text{C}^\circ$ , typical (max. $\pm 4 \text{ parts } 10^9$ over $20^\circ$ change within $-20^\circ$ to $50^\circ\text{C}$ ). |
| $\pm 10\%$ change in line voltage from specified:          | $\pm 5 \text{ parts } 10^{10}$ .                                                                                                                              |
| Long-term aging rate:                                      | $\pm 3 \text{ parts } 10^8/30 \text{ days.}$                                                                                                                  |

### DRAWINGS

Option 12, 3 MHz Oscillator Final Assembly #C45383  
Option 12, 3 MHz Oscillator Power Supply P.C. Assembly #B39367  
Option 12, 3 MHz Oscillator Power Supply Schematic #B39364  
Option 12, 3 MHz Oscillator Final Assembly Parts List #P/L45383







NOTE: (EXCEPT AS NOTED)

1) RESISTORS- 1/4 W, 5%.

2) C9 ON POWER SUPPLY CHASSIS 39189

# OPTION 12 OSCILLATOR FINAL ASSEMBLY PARTS LIST

| Ref. | Description                              | SD<br>Part No. |
|------|------------------------------------------|----------------|
|      | Option 12 Oscillator Final Assembly      | C45383         |
|      | <u>ADD</u>                               |                |
| A2   | See 3 MHz Oscillator Power P.C. Assembly | B39367         |
| C9   | Capacitor, 500 $\mu$ F, 50 V             | 02386060       |
| T2   | Transformer                              | B19805         |
| U1   | Oscillator                               | C33427         |

\* \* \* \* \*

## 3 MHz OSCILLATOR POWER SUPPLY P.C. ASSEMBLY

| Ref. | Description                           | SD<br>Part No. |
|------|---------------------------------------|----------------|
|      | 3 MHz Oscillator Power P.C. Assembly  | B39367         |
|      | 3 MHz Oscillator Power P.C. Schematic | B39364         |
| C1   | Capacitor, 100 pF, 5%, 500 V          | C0536          |
| C2   | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| CR1  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR2  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR3  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR4  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| Q1   | Transistor, 2N5190                    | Q0281          |
| Q2   | Transistor, 2N3646                    | Q0218          |
| R1   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R2   | Resistor, 27 k, 5%, 1/4 W             | R0824          |
| R3   | Resistor, 20 k, 5%, 1/4 W             | R0964          |
| R4   | Resistor, 6.8 k, 5%, 1/4 W            | R0696          |
| R5   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R6   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| R7   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| R8   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| U1   | Integrated Circuit, U723C             | 25756          |
| U2   | Integrated Circuit, 7473N             | 19709          |





## OPTION 13 OSCILLATOR

### DESCRIPTION

This oscillator option provides higher stability than the standard oscillator. The added assemblies include: U1, 3 MHz Oscillator and A2, 3 MHz Oscillator Power Supply.

### SPECIFICATIONS

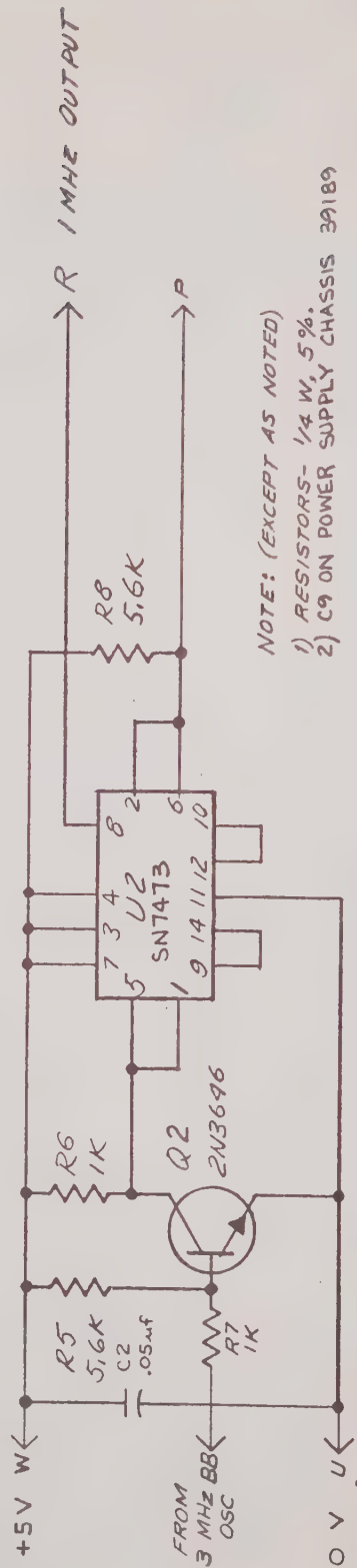
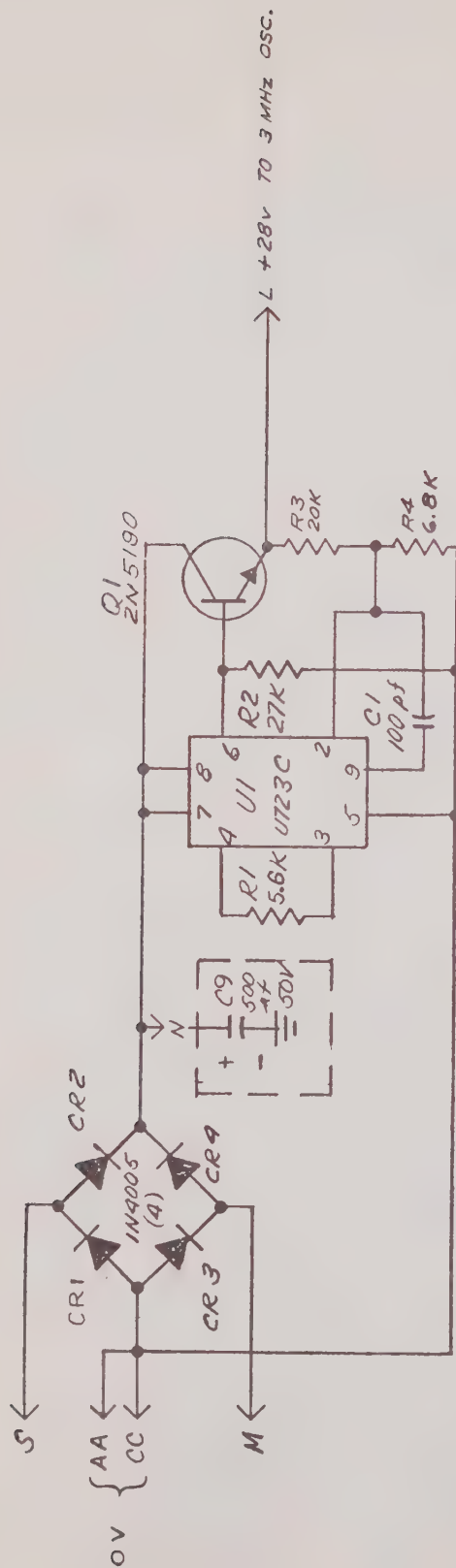
|                                                            |                                                                                                            |
|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Aging rate after warm-up:                                  | $\pm 5$ parts $10^{10}$ /24 hrs.                                                                           |
| Maximum warm-up for "OFF" periods to 1 week:               | 72 hrs.                                                                                                    |
| Frequency retrace for "OFF" periods up to approx. 24 hrs.: | 1 hr. typical to reach $< \pm 5$ parts $10^9$ .                                                            |
| Short-term aging rate:                                     | $\pm 5$ parts $10^{11}$ rms for 1 sec average.                                                             |
| Temperature variation:                                     | $< \pm 2$ parts $10^{10}$ /C°, typical (max. $\pm 4$ parts in $10^9$ over 20° change within -20° to 50°C). |
| $\pm 10\%$ change in line voltage from specified:          | $\pm 5$ parts $10^{11}$ .                                                                                  |
| Long-term aging rate:                                      | $\pm 1.5$ parts $10^8$ /30 days.                                                                           |

### DRAWINGS

Option 13, 3 MHz Oscillator Final Assembly #C45384  
Option 13, 3 MHz Oscillator Power Supply P.C. Assembly #B39367  
Option 13, 3 MHz Oscillator Power Supply Schematic #B39364  
Option 13, 3 MHz Oscillator Final Assembly Parts List #P/L45384







NOTE: (EXCEPT AS NOTED)

1) RESISTORS- 1/4 W, 5%.

2) C9 ON POWER SUPPLY CHASSIS 39189

# OPTION 13 OSCILLATOR FINAL ASSEMBLY PARTS LIST

| Ref. | Description                              | SD<br>Part No. |
|------|------------------------------------------|----------------|
|      | Option 13 Oscillator Final Assembly      | C45384         |
|      | <u>ADD</u>                               |                |
| A2   | See 3 MHz Oscillator Power P.C. Assembly | B39367         |
| C9   | Capacitor, 500 $\mu$ F, 50 V             | 03286060       |
| T2   | Transformer                              | B19805         |
| U1   | Oscillator                               | C33429         |

\* \* \* \* \*

## 3 MHz OSCILLATOR POWER P.C. ASSEMBLY

| Ref. | Description                           | SD<br>Part No. |
|------|---------------------------------------|----------------|
|      | 3 MHz Oscillator Power P.C. Assembly  | B39367         |
|      | 3 MHz Oscillator Power P.C. Schematic | B39364         |
| C1   | Capacitor, 100 pF, 5%, 500 V          | C0536          |
| C2   | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| CR1  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR2  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR3  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| CR4  | Diode, 1N4005, 600 V, 1 A             | CR0284         |
| Q1   | Transistor, 2N5190                    | Q0281          |
| Q2   | Transistor, 2N3646                    | Q0218          |
| R1   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R2   | Resistor, 27 k, 5%, 1/4 W             | R0824          |
| R3   | Resistor, 20 k, 5%, 1/4 W             | R0964          |
| R4   | Resistor, 6.8 k, 5%, 1/4 W            | R0696          |
| R5   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| R6   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| R7   | Resistor, 1 k, 5%, 1/4 W              | R0765          |
| R8   | Resistor, 5.6 k, 5%, 1/4 W            | R0821          |
| U1   | Integrated Circuit, U723C             | 25756          |
| U2   | Integrated Circuit, 7473N             | 19709          |





OPTION 15  
ONE ADDED READOUT DIGIT

This option adds one (1) readout digit to the left hand, most significant digit position on the A1, Readout P.C. board.

Reference Drawings:

A1, Readout P.C. Assembly #C39383 (see text)  
A1, Readout Schematic #E39380 (see text)  
Option 15, Final Assembly Parts List #P/L45482

# OPTION 15 FINAL ASSEMBLY (8 DIGIT) PARTS LIST

| Ref. | Description                        | SD<br>Part No. |
|------|------------------------------------|----------------|
|      | Option 15 Final Assembly (8 Digit) | P/L45482       |
| U8   | Integrated Circuit, SN74141N       | 25730          |
| U18  | Integrated Circuit, SN7475N        | 19710          |
| U26  | Integrated Circuit, SN7490N        | 25732          |
| V8   | Readout Tube, NL58595              | V0131          |
| XV8  | Socket Readout Tube                | X0179          |

OPTION 16  
TWO ADDED READOUT DIGITS

This option adds two (2) readout digits to the left hand, most significant digit position on the A1, Readout P.C. Board.

DRAWINGS

A1, Readout P.C. Assembly #C39383 (see text)  
A1, Readout Schematic #E39380 (see text)  
Option 16, Final Assembly Parts List #P/L45483

# OPTION 16 FINAL ASSEMBLY (9 DIGIT) PARTS LIST

| Ref. | Description                        | SD<br>Part No. |
|------|------------------------------------|----------------|
|      | Option 16 Final Assembly (9 Digit) | P/L45483       |
| U8   | Integrated Circuit, SN74141N       | 25730          |
| U9   | Integrated Circuit, SN74141N       | 25730          |
| U18  | Integrated Circuit, SN7475N        | 19710          |
| U19  | Integrated Circuit, SN7475N        | 19710          |
| U26  | Integrated Circuit, SN7490N        | 25732          |
| U27  | Integrated Circuit, SN7490N        | 25732          |
| V8   | Readout Tube, NL5859S              | V0131          |
| V9   | Readout Tube, NL5859S              | V0131          |
| XV8  | Socket, Readout Tube               | X0179          |
| XV9  | Socket, Readout Tube               | X0179          |

OPTION 20  
REMOTE PROGRAMMING  
(All Controls, Group Binary, Ground True)

DESCRIPTION

This Option provides remote control of all switchable front panel controls, with the exception of the POWER switch, in a group binary format. The remote control circuits use ground "0" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500

REMOTE PIN ASSIGNMENTS

| <u>PIN</u>           | <u>FUNCTION</u>       |
|----------------------|-----------------------|
| 38                   | A x 1                 |
| 37                   | A x 10                |
| leave 38 and 37 open | A x 100               |
| 36                   | A-DC                  |
| 34                   | B x 1                 |
| 33                   | B x 10                |
| leave 34 and 33 open | B x 100               |
| 32                   | B-DC                  |
| 31                   | B (SLOPE)             |
| 30                   | C x 1                 |
| 29                   | C x 10                |
| leave 30 and 29 open | C x 100               |
| 28                   | C-DC                  |
| 27                   | C (SLOPE)             |
| 35                   | B+C COM.              |
| 50                   | REMOTE/LOCAL          |
| 26                   | GND                   |
| 5                    | "0" = TEST            |
| 4                    | "0" = FAST/"1" = SLOW |
| 3                    | "0" = RATIO           |
| 2                    | "0" = RESET           |
| 6                    | RESOLUTION CODE       |
| 7                    | RESOLUTION CODE       |
| 8                    | RESOLUTION CODE       |
| 9                    | RESOLUTION CODE       |
| 10                   | FUNCTION CODE         |
| 11                   | FUNCTION CODE         |
| 12                   | FUNCTION CODE         |
| 13                   | FUNCTION CODE         |



# REMOTE PIN ASSIGNMENTS (Cont'd)

## PIN

## FUNCTION

25  
1

REMOTE/LOCAL  
GND

RESOLUTION  
CODE

PIN NO.  
6 7 8 9

|             |   |   |   |   |
|-------------|---|---|---|---|
| .1 Hz       | 1 | 1 | 1 | 1 |
| 1 SEC       | 1 | 1 | 1 | 0 |
| 100 ms      | 1 | 1 | 0 | 1 |
| 10 ms       | 1 | 1 | 0 | 0 |
| 1 ms        | 1 | 0 | 1 | 1 |
| 100 $\mu$ s | 1 | 0 | 1 | 0 |
| 10 $\mu$ s  | 1 | 0 | 0 | 1 |
| 1 $\mu$ s   | 1 | 0 | 0 | 0 |
| 100 ns      | 0 | 1 | 1 | 1 |
| 10 ns       | 0 | 1 | 1 | 0 |

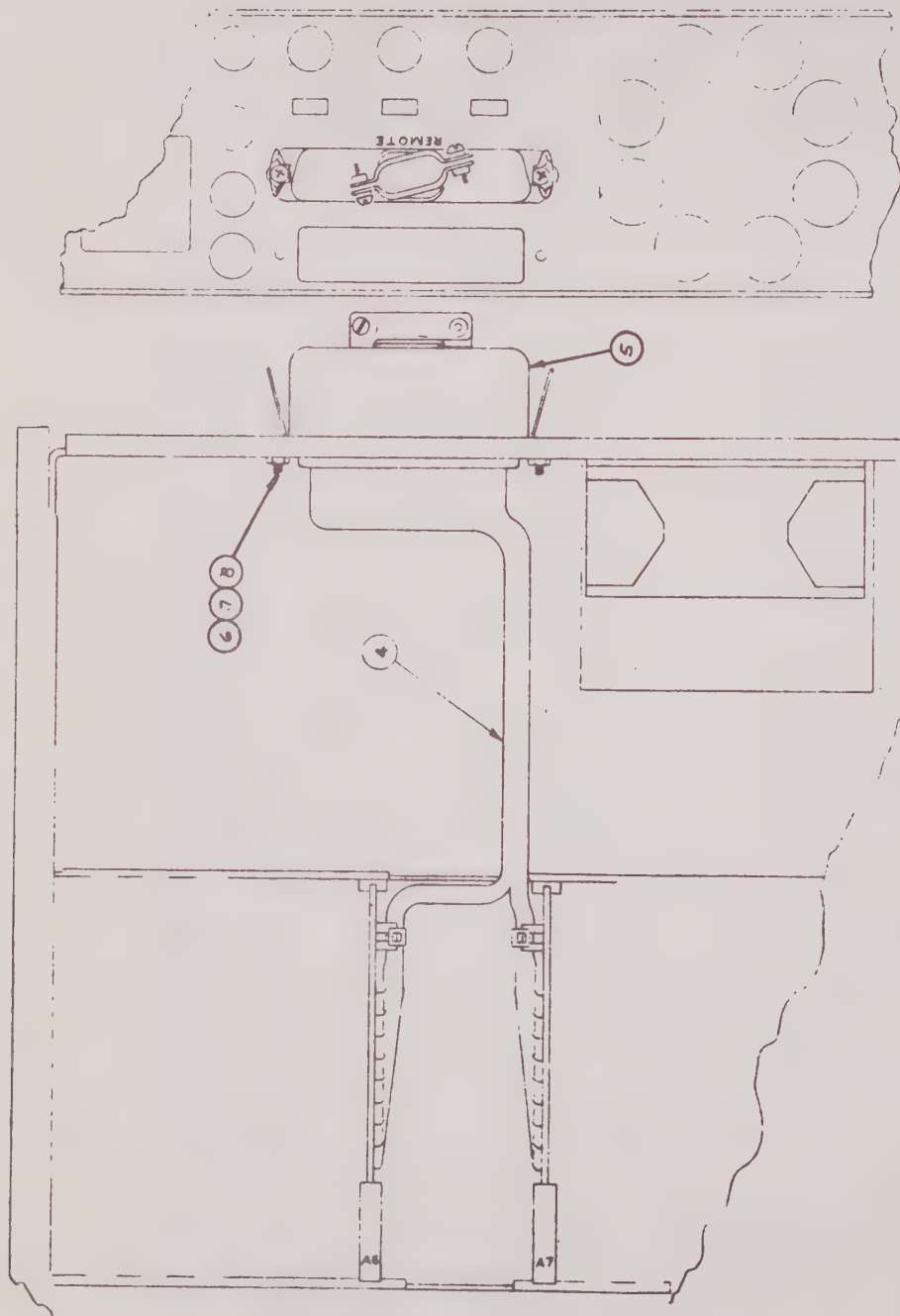
FUNCTION  
CODE

PIN NO.  
10 11 12 13

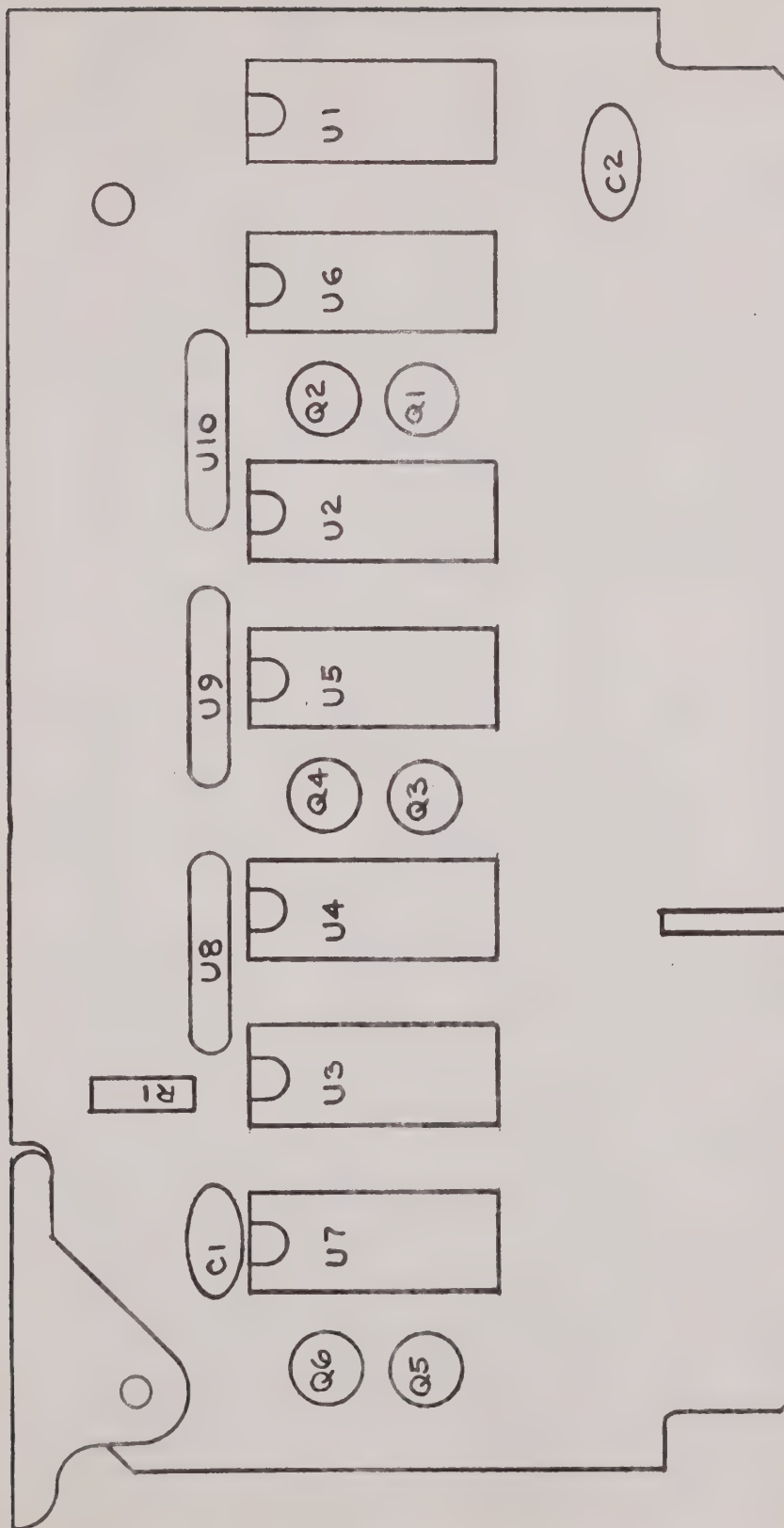
|                       |   |   |   |   |
|-----------------------|---|---|---|---|
| TIM                   | 1 | 1 | 1 | 1 |
| RATE D                | 1 | 1 | 1 | 0 |
| RATE A                | 1 | 1 | 0 | 1 |
| COUNT A               | 1 | 1 | 0 | 0 |
| HOLD                  | 1 | 0 | 1 | 1 |
| P/R x 1               | 1 | 0 | 1 | 0 |
| P/R x 10              | 1 | 0 | 0 | 1 |
| P/R x 10 <sup>2</sup> | 1 | 0 | 0 | 0 |
| P/R x 10 <sup>3</sup> | 0 | 1 | 1 | 1 |
| P/R x 10 <sup>4</sup> | 0 | 1 | 1 | 0 |
| P/R x 10 <sup>5</sup> | 0 | 1 | 0 | 1 |

## DRAWINGS

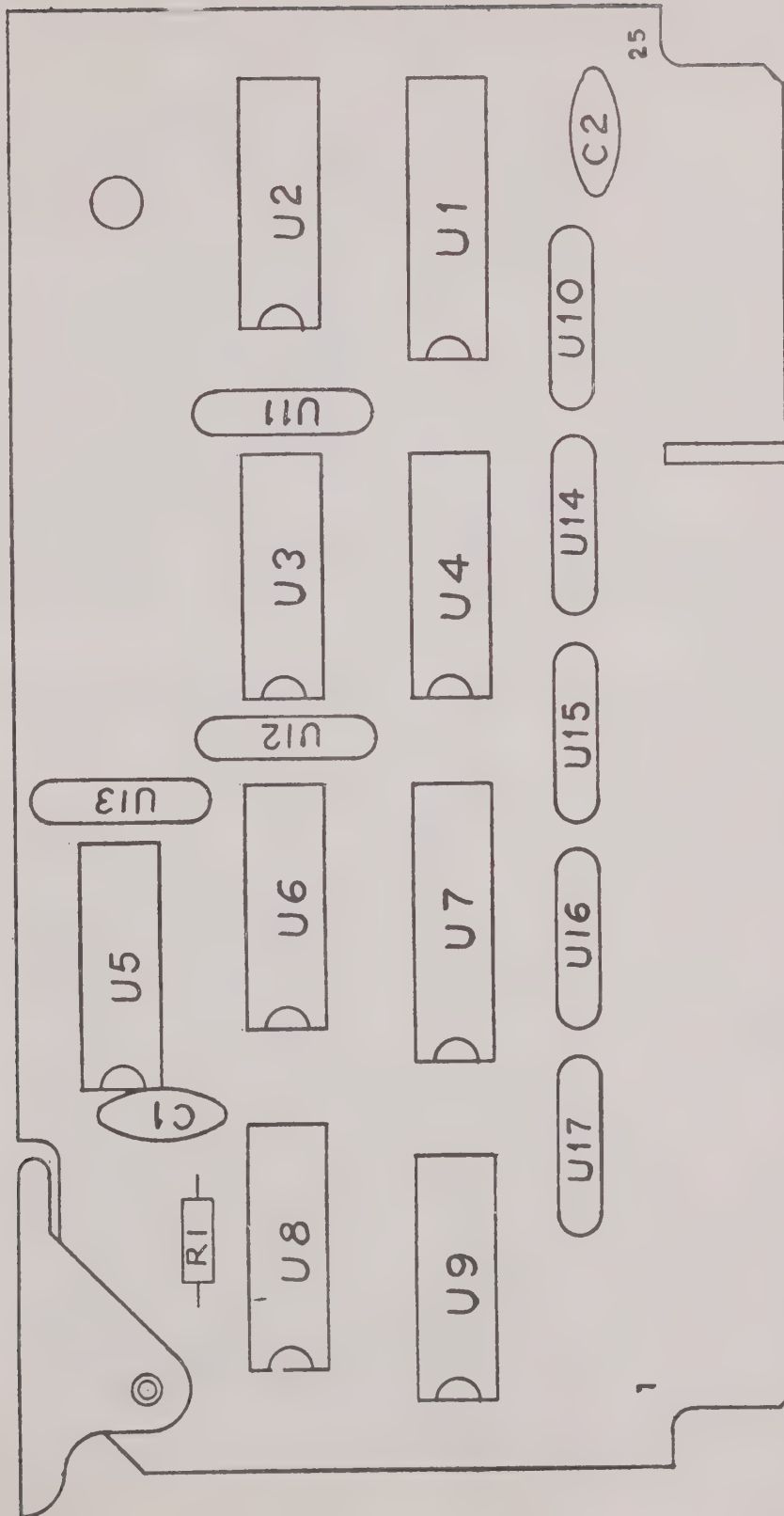
Option 20, Final Assembly #C45356  
Option 20, A6, Binary Attenuator Select P.C. Assembly #C39756  
Option 20, A6, Binary Attenuator Select Schematic #C39753  
Option 20, A7, Binary Function Select P.C. Assembly #C39760  
Option 20, A7, Binary Function Select Schematic #C39757  
Option 20, Final Assembly Parts List #P/L45356



OPTION 20, FINAL ASSEMBLY #C45356











# OPTION 20 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                             | SD<br>Part No. |
|------|-----------------------------------------|----------------|
|      | Option 20 Final Assembly                | C45356         |
|      | <u>ADD</u>                              |                |
| 4    | Binary Remote Assembly consisting of:   | C45355         |
| 6    | Binary Remote Cable Assembly            | B45354         |
| 4    | Binary Attenuator Select P.C. Assembly  | C39756         |
| 5    | Binary Function Select P.C. Assembly    | C39760         |
| P14  | Connector, w/hood, 50 pin               | J0171          |
|      | * * * * *                               |                |
| J14  | Binary Remote Cable Assembly            | 35354          |
|      | Connector, 50 pin                       | J0170          |
|      | * * * * *                               |                |
| A6   | Binary Attenuator Select P.C. Assembly  | C39756         |
| A6   | Binary Attenuator Select P.C. Schematic | C39753         |
| C1   | Capacitor, .05 $\mu$ F, 12 V            | C0672          |
| C2   | Capacitor, .05 $\mu$ F, 12 V            | C0672          |
| Q1   | Transistor, 2N3646                      | Q0218          |
| Q2   | Transistor, 2N3646                      | Q0218          |
| Q3   | Transistor, 2N3646                      | Q0218          |
| Q4   | Transistor, 2N3646                      | Q0218          |
| Q5   | Transistor, 2N3646                      | Q0218          |
| Q6   | Transistor, 2N3646                      | Q0218          |
| R1   | Resistor, 4.7 k, 5%, 1/4 W              | R0892          |
| U1   | Integrated Circuit, MC857P              | 25753          |
| U2   | Integrated Circuit, MC1810P             | 25735          |
| U3   | Integrated Circuit, MC1808P             | 25734          |
| U4   | Integrated Circuit, SN15862N            | 19719          |
| U5   | Integrated Circuit, MC836P              | 25704          |
| U6   | Integrated Circuit, MC1808P             | 25734          |
| U7   | Integrated Circuit, MC836P              | 25704          |
| U8   | Resistor Network, 5 k, 1/10 W           | A27867         |
| U9   | Resistor Network, 5 k, 1/10 W           | A27867         |
| U10  | Resistor Network, 5 k, 1/10 W           | A27867         |
|      | * * * * *                               |                |

# OPTION 20 FINAL ASSEMBLY PARTS LIST (Cont'd)

| Ref.          | Description                           | SD<br>Part No. |
|---------------|---------------------------------------|----------------|
| A7            | Binary Function Select P.C. Assembly  | C39760         |
| A7            | Binary Function Select P.C. Schematic | C39757         |
| C1            | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| C2            | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| R1            | Resistor, 4.7 k, 5%, 1/4 W            | R0892          |
| U1            | Integrated Circuit, SN74145N          | 25754          |
| U2            | Integrated Circuit, SN15846N          | 19716          |
| U3            | Integrated Circuit, MC1806P           | 25733          |
| U4            | Integrated Circuit, SN15862N          | 19719          |
| U5            | Integrated Circuit, MC1808P           | 25734          |
| U6            | Integrated Circuit, SN15846N          | 19716          |
| U7            | Integrated Circuit, SN74145N          | 25754          |
| U8            | Integrated Circuit, MC857P            | 25753          |
| U9            | Integrated Circuit, MC1808P           | 25734          |
| U10           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U11           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U12           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U13           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U14           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U15           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U16           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U17           | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| <u>DELETE</u> |                                       |                |
| A6            | Attenuator Select P.C. Assembly       | B39355         |
| A7            | Function Select P.C. Assembly         | B39803         |
| X15           | Cover Plate, 50 pin                   | 39443-2        |

OPTION 21  
REMOTE PROGRAMMING  
(All Controls, Single Line, Ground True)

DESCRIPTION

This Option provides remote control of all switchable front panel controls, with the exception of the POWER switch, in a single line format. The remote control circuits use ground "1" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500.

REMOTE PIN ASSIGNMENTS

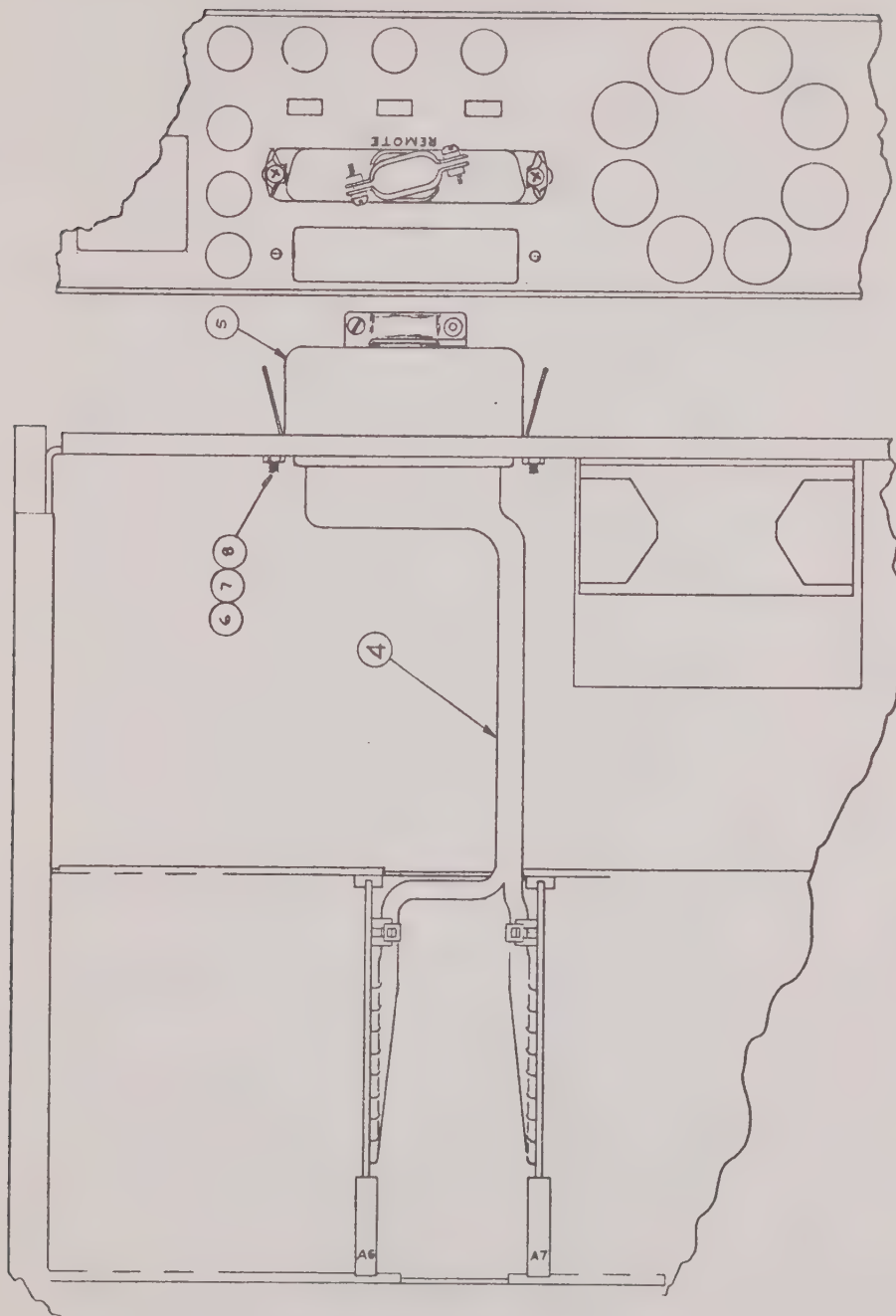
| <u>PIN</u> | <u>DESCRIPTION</u>    |
|------------|-----------------------|
| 1          | TEST                  |
| 2          | RATIO                 |
| 3          | 10 ns                 |
| 4          | 100 ns                |
| 5          | 1 $\mu$ s             |
| 6          | 10 $\mu$ s            |
| 7          | 100 $\mu$ s           |
| 8          | 1 ms                  |
| 9          | 10 ms                 |
| 10         | 100 ms                |
| 11         | 1 SEC                 |
| 12         | .1 Hz                 |
| 13         | FAST RECYCLE RATE     |
| 14         | TIM                   |
| 15         | RATE D                |
| 16         | RATE A                |
| 17         | COUNT A               |
| 18         | HOLD                  |
| 19         | P/R x 1               |
| 20         | P/R x 10              |
| 21         | P/R x 10 <sup>2</sup> |
| 22         | P/R x 10 <sup>3</sup> |
| 23         | P/R x 10 <sup>4</sup> |
| 24         | P/R x 10 <sup>5</sup> |
| 25         | A x 1                 |
| 26         | A x 10                |
| 27         | A x 100               |
| 28         | A-DC                  |
| 29         | B x 1                 |
| 30         | B x 10                |
| 31         | B x 100               |
| 32         | B-DC                  |
| 33         | B ("-" SLOPE)         |
| 34         | C x 1                 |
| 35         | C x 10                |
| 36         | C x 100               |
| 37         | C-DC                  |

## REMOTE PIN ASSIGNMENTS (Cont'd)

| <u>PIN</u> | <u>DESCRIPTION</u>            |
|------------|-------------------------------|
| 38         | C ("-" SLOPE)                 |
| 39         | B+C COM.                      |
| 40         | RESET                         |
| 47         | REMOTE AMPLIFIERS             |
| 48         | REMOTE FUNCTION AND TIME BASE |
| 49         | GND                           |
| 50         | GND                           |

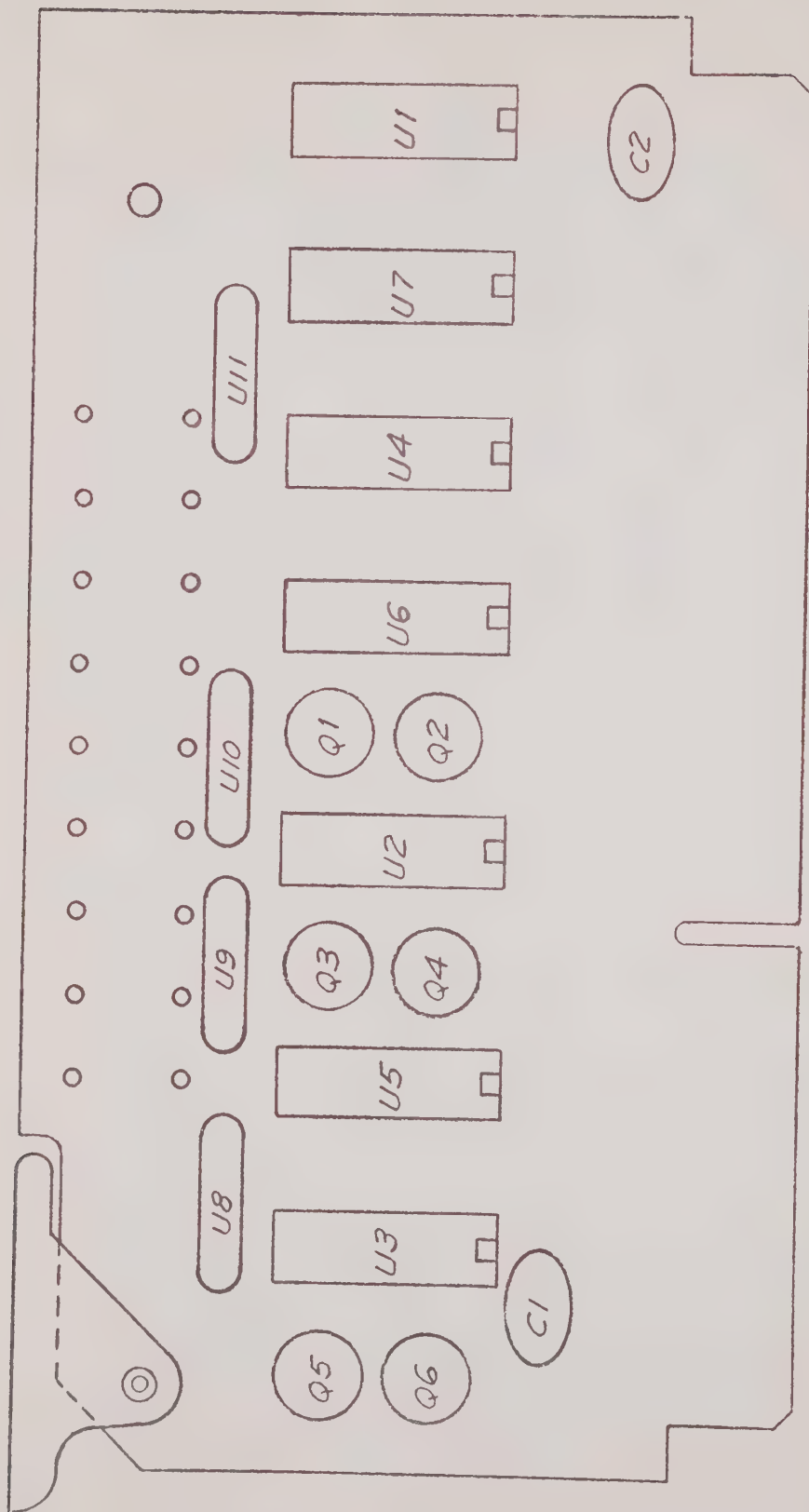
## DRAWINGS

Option 21, Final Assembly #C45084  
Option 21, A6, Single Line Attenuator Select P.C. Assembly #B39752  
Option 21, A6, Single Line Attenuator Select Schematic #C39749  
Option 21, A7, Single Line Function Select P.C. Assembly #B39748  
Option 21, A7, Single Line Function Select Schematic #D39745  
Option 21, Final Assembly Parts List #P/L45084

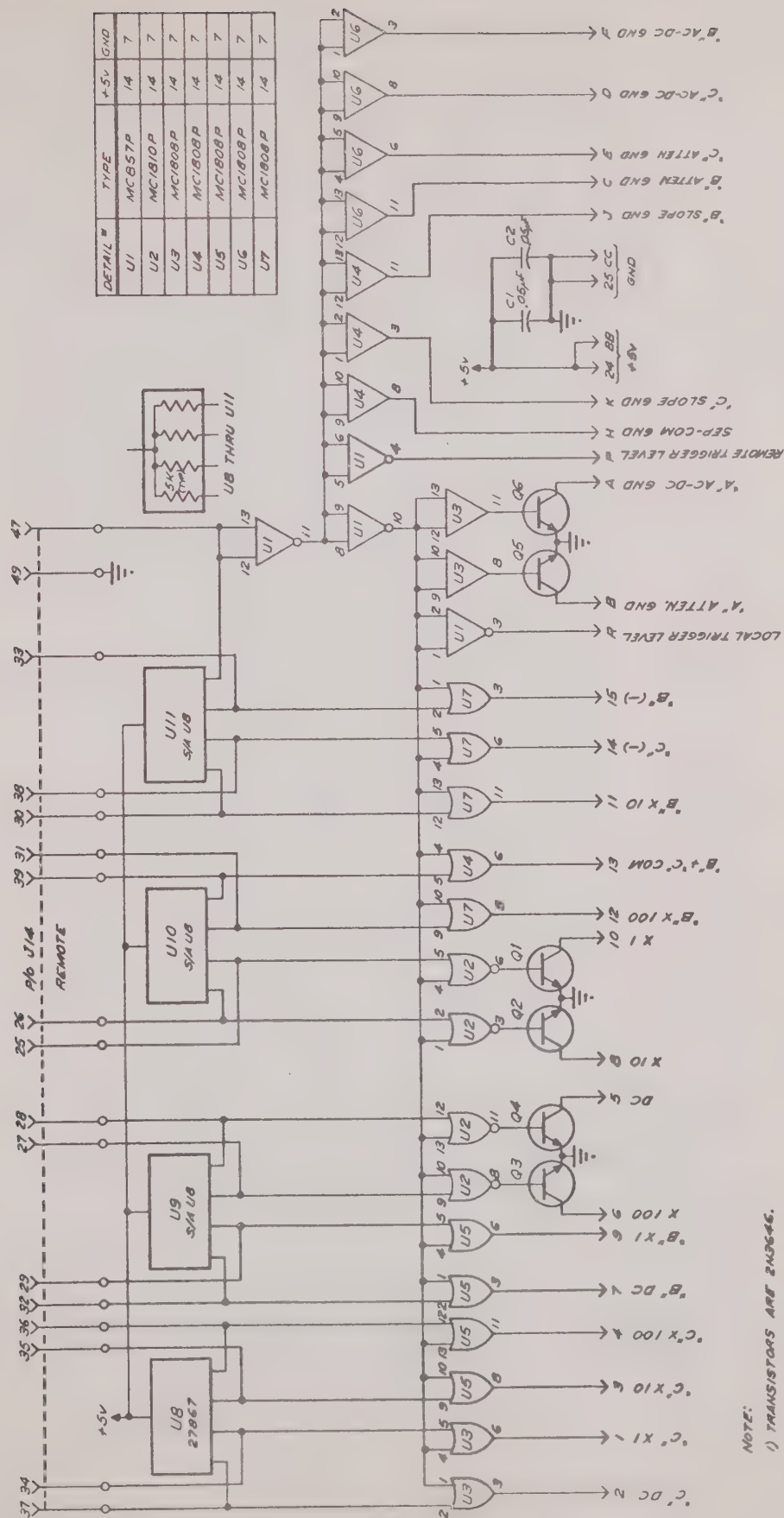


OPTION 21, FINAL ASSEMBLY #C45084

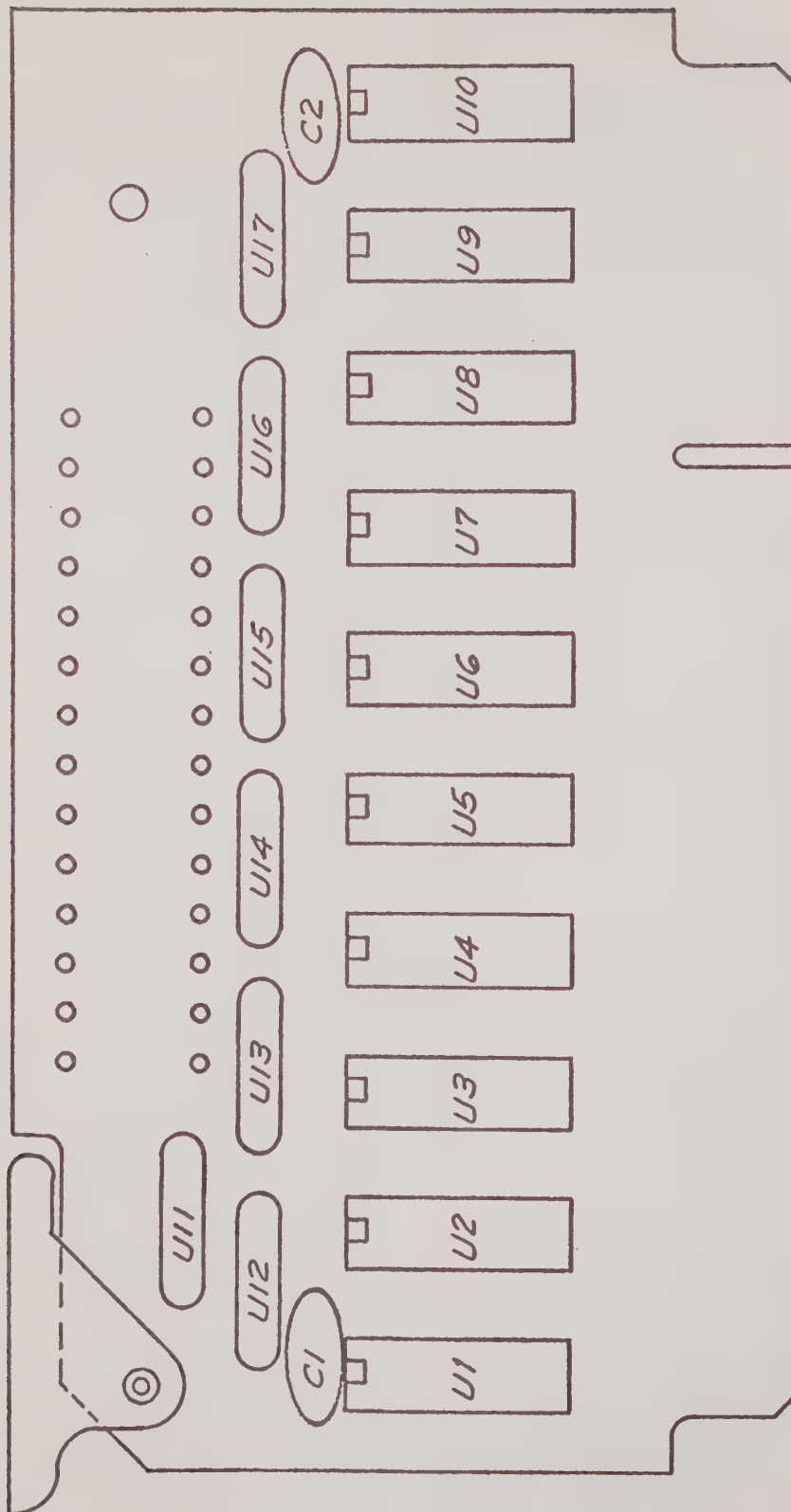




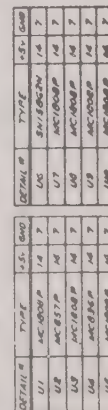
OPTION 21, A6, SINGLE LINE ATTENUATOR SELECT P.C. ASSEMBLY #B39752



OPTION 21, A6, SINGLE LINE ATTENUATOR SELECT SCHEMATIC #C39749



OPTION 21, A7, SINGLE LINE FUNCTION SELECT P.C. ASSEMBLY #B39748



OPTION 21, A7, SINGLE LINE FUNCTION SELECT SCHEMATIC #D39745

# OPTION 21 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                                  | SD<br>Part No. |
|------|----------------------------------------------|----------------|
|      | Option 21 Final Assembly                     | C45084         |
|      | <u>ADD</u>                                   |                |
| 4    | Single Line Remote Assembly consisting of:   | C39808         |
| 4    | Single Line Attenuator Select P.C. Assembly  | B39752         |
| 5    | Single Line Function Select P.C. Assembly    | B39748         |
| 6    | Single Line Remote Cable Assembly            | B39807         |
| P14  | Connector, w/hood, 50 pin                    | J0171          |
|      | * * * * *                                    |                |
| A6   | Single Line Attenuator Select P.C. Assembly  | B39752         |
| A6   | Single Line Attenuator Select P.C. Schematic | C39749         |
| C1   | Capacitor, .05 $\mu$ F, 12 V                 | C0672          |
| C2   | Capacitor, .05 $\mu$ F, 12 V                 | C0672          |
| Q1   | Transistor, 2N3646                           | Q0218          |
| Q2   | Transistor, 2N3646                           | Q0218          |
| Q3   | Transistor, 2N3646                           | Q0218          |
| Q4   | Transistor, 2N3646                           | Q0218          |
| Q5   | Transistor, 2N3646                           | Q0218          |
| Q6   | Transistor, 2N3646                           | Q0218          |
| U1   | Integrated Circuit, MC857P                   | 25753          |
| U2   | Integrated Circuit, MC1810P                  | 25735          |
| U3   | Integrated Circuit, MC1808P                  | 25734          |
| U4   | Integrated Circuit, MC1808P                  | 25734          |
| U5   | Integrated Circuit, MC1808P                  | 25734          |
| U6   | Integrated Circuit, MC1808P                  | 25734          |
| U7   | Integrated Circuit, MC1808P                  | 25734          |
| U8   | Resistor Network, 4 x 5 k, 1/10 W            | 27867          |
| U9   | Resistor Network, 4 x 5 k, 1/10 W            | 27867          |
| U10  | Resistor Network, 4 x 5 k, 1/10 W            | 27867          |
| U11  | Resistor Network, 4 x 5 k, 1/10 W            | 27867          |
|      | * * * * *                                    |                |
| A7   | Single Line Function Select P.C. Assembly    | B39748         |
| A7   | Single Line Function Select P.C. Schematic   | D39745         |
| C1   | Capacitor, .05 $\mu$ F, 12 V                 | C0672          |
| C2   | Capacitor, .05 $\mu$ F, 12 V                 | C0672          |

# OPTION 21 FINAL ASSEMBLY PARTS LIST (Cont'd)

| Ref.          | Description                       | SD<br>Part No. |
|---------------|-----------------------------------|----------------|
| U1            | Integrated Circuit, MC1808P       | 25734          |
| U2            | Integrated Circuit, MC857P        | 25653          |
| U3            | Integrated Circuit, MC1808P       | 25734          |
| U4            | Integrated Circuit, MC836P        | 25704          |
| U5            | Integrated Circuit, MC1808P       | 25734          |
| U6            | Integrated Circuit, SN15862N      | 19719          |
| U7            | Integrated Circuit, MC1808P       | 25734          |
| U8            | Integrated Circuit, MC1808P       | 25734          |
| U9            | Integrated Circuit, MC1808P       | 25734          |
| U10           | Integrated Circuit, MC1808P       | 25734          |
| U11           | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U12           | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U13           | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U14           | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U15           | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U16           | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| U17           | Resistor Network, 4 x 5 k, 1/10 W | 27867          |
| * * * * *     |                                   |                |
|               | Single Line Remote Cable Assembly | B39807         |
| J14           | Connector, 50 pin                 | J0170          |
| <u>DELETE</u> |                                   |                |
| A6            | Attenuator Select P.C. Assembly   | B39355         |
| A7            | Function Select P.C. Assembly     | B39803         |
| X15           | Cover Plate, 50 pin               | 39443-2        |





OPTION 22  
REMOTE PROGRAMMING  
(Function and Resolution, Group Binary, Ground True)

DESCRIPTION

This Option provides remote control of the Function and Resolution controls in a group binary format. The remote control circuits use ground "1" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500.

REMOTE PIN ASSIGNMENTS

| <u>PIN</u> | <u>DESCRIPTION</u>    |
|------------|-----------------------|
| 5          | "0" = TEST            |
| 4          | "0" = FAST/"1" = SLOW |
| 3          | "0" = RATIO           |
| 2          | "0" = RESET           |
| 6          | RESOLUTION CODE       |
| 7          | RESOLUTION CODE       |
| 8          | RESOLUTION CODE       |
| 9          | RESOLUTION CODE       |
| 10         | FUNCTION CODE         |
| 11         | FUNCTION CODE         |
| 12         | FUNCTION CODE         |
| 13         | FUNCTION CODE         |
| 25         | REMOTE/LOCAL          |
| 1          | GND                   |

| RESOLUTION<br>CODE | PIN NO. |   |   |   |
|--------------------|---------|---|---|---|
|                    | 6       | 7 | 8 | 9 |
| .1 Hz              | 1       | 1 | 1 | 1 |
| 1 SEC              | 1       | 1 | 1 | 0 |
| 100 ms             | 1       | 1 | 0 | 1 |
| 10 ms              | 1       | 1 | 0 | 0 |
| 1 ms               | 1       | 0 | 1 | 1 |
| 100 $\mu$ s        | 1       | 0 | 1 | 0 |
| 10 $\mu$ s         | 1       | 0 | 0 | 1 |
| 1 $\mu$ s          | 1       | 0 | 0 | 0 |
| 100 ns             | 0       | 1 | 1 | 1 |
| 10 ns              | 0       | 1 | 1 | 0 |

| FUNCTION<br>CODE      | PIN NO. |    |    |    |
|-----------------------|---------|----|----|----|
|                       | 10      | 11 | 12 | 13 |
| TIM                   | 1       | 1  | 1  | 1  |
| RATE D                | 1       | 1  | 1  | 0  |
| RATE A                | 1       | 1  | 0  | 1  |
| COUNT A               | 1       | 1  | 0  | 0  |
| HOLD                  | 1       | 0  | 1  | 1  |
| P/R x 1               | 1       | 0  | 1  | 0  |
| R/R x 10              | 1       | 0  | 0  | 1  |
| P/R x 10 <sup>2</sup> | 1       | 0  | 0  | 0  |
| P/R x 10 <sup>3</sup> | 0       | 1  | 1  | 1  |
| P/R x 10 <sup>4</sup> | 0       | 1  | 1  | 0  |
| P/R x 10 <sup>5</sup> | 0       | 1  | 0  | 1  |

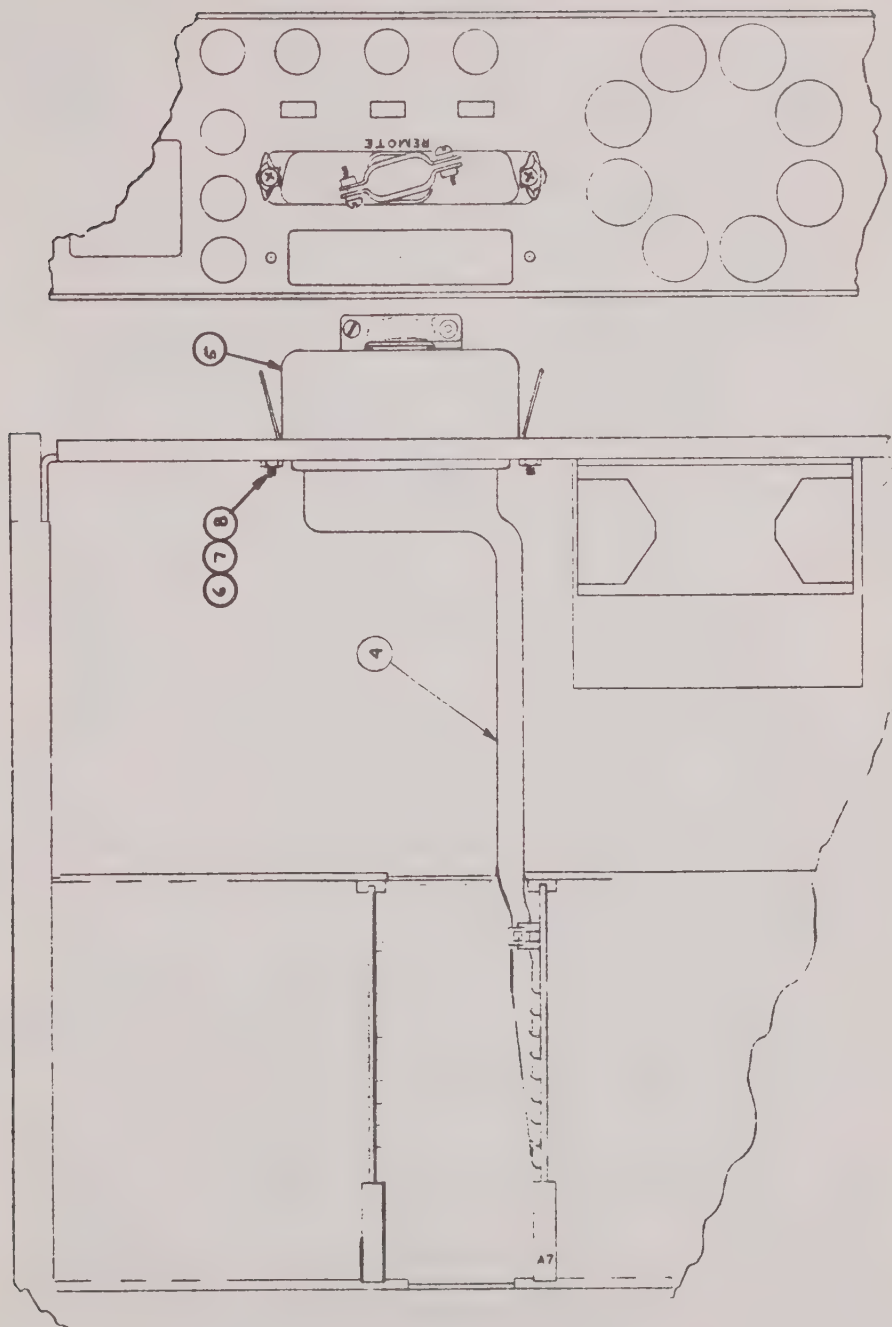
## DRAWINGS

Option 22, Final Assembly #C45363

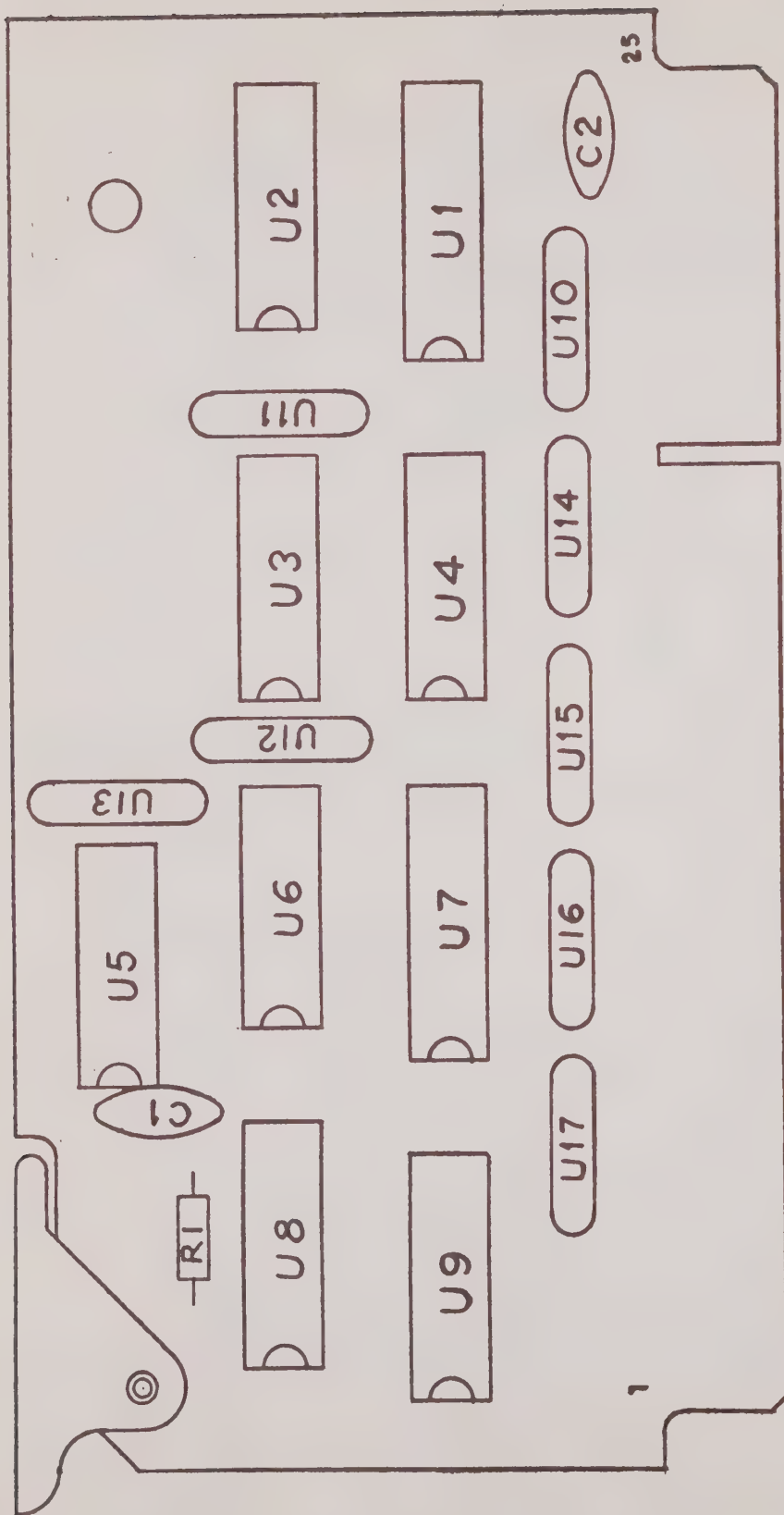
Option 22, A7, Binary Function Select P.C. Assembly #C39760

Option 22, A7, Binary Function Select Schematic #C39757

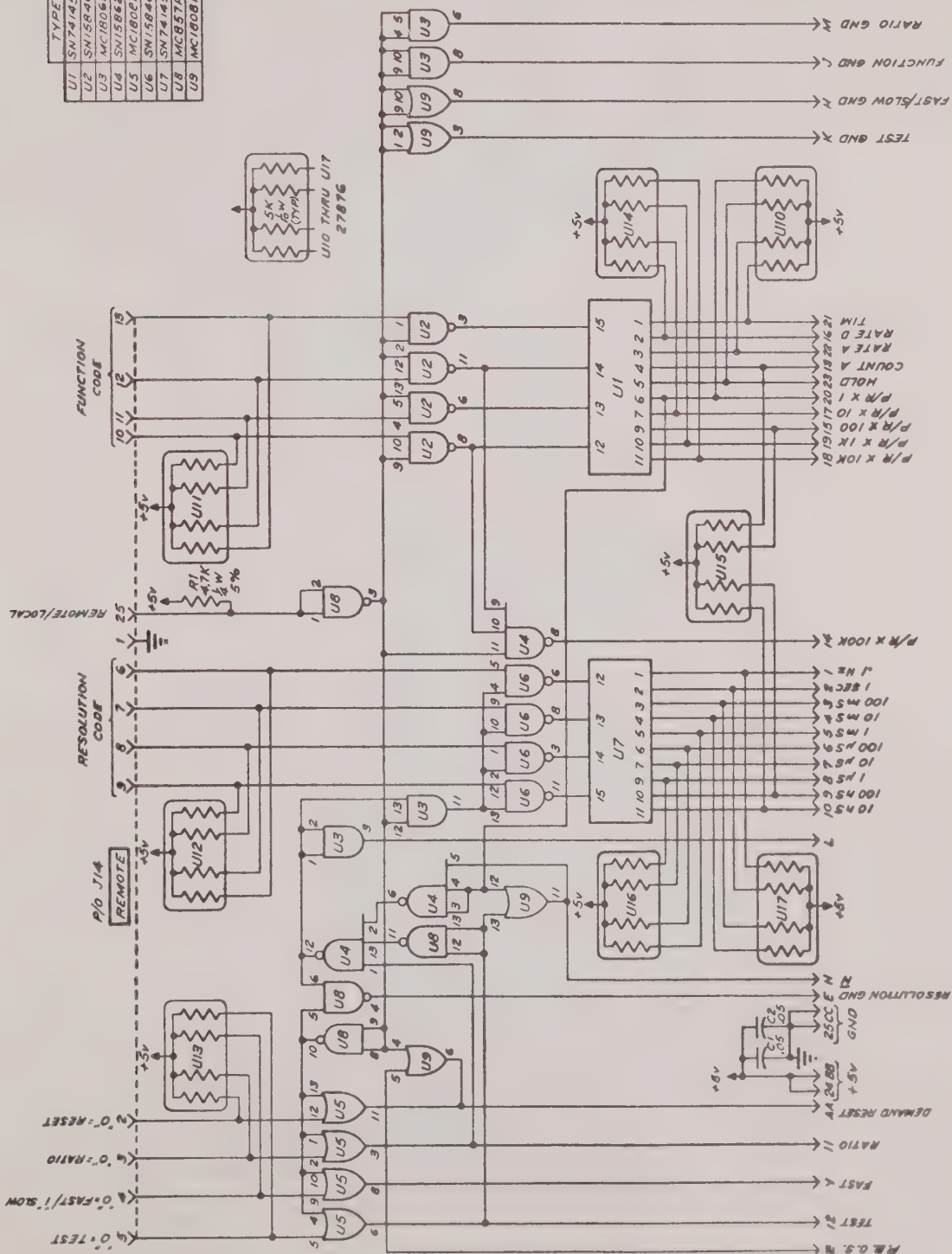
Option 22, Final Assembly Parts List #P/L45363



OPTION 22, FINAL ASSEMBLY #C45363



OPTION 22, A7, BINARY FUNCTION SELECT P.C. ASSEMBLY #C39760



| TYPE | +5V      | GND  |
|------|----------|------|
| U1   | SN74145N | 16 8 |
| U2   | SN74146N | 14 7 |
| U3   | MC1806P  | 14 7 |
| U4   | SN15862N | 14 7 |
| U5   | MC1806P  | 14 7 |
| U6   | SN15846N | 14 7 |
| U7   | SN74145N | 16 8 |
| U8   | MC1806P  | 14 7 |
| U9   | MC1806P  | 14 7 |

\*1 = +5V = LOCAL = SLOW  
 \*0 = 0V = REMOTE = FAST

| PIN #       | FUNCTION      | CODE    |
|-------------|---------------|---------|
| 10 11 12 13 | TIM           | 1 1 1 1 |
| 1 1 1 1     | RATE D        | 1 1 1 0 |
| 1 1 1 1     | RATE A        | 1 1 0 1 |
| 1 1 1 1     | COUNT A       | 1 1 0 0 |
| 1 0 1 1     | HOLD          | 1 0 1 1 |
| 1 0 1 1     | P/R x 1       | 1 0 1 0 |
| 1 0 1 1     | P/R x 10      | 1 0 1 0 |
| 1 0 1 1     | P/R x 100     | 1 0 1 0 |
| 1 0 1 1     | P/R x 1000    | 1 0 1 1 |
| 1 0 1 1     | P/R x 10000   | 1 0 1 1 |
| 1 0 1 1     | P/R x 100000  | 1 0 1 1 |
| 1 0 1 1     | P/R x 1000000 | 1 0 1 1 |

| PIN #   | RESOLUTION | CODE    |
|---------|------------|---------|
| 6 7 8 9 | 1 Hz       | 1 1 1 1 |
| 1 1 1 1 | 1 SEC      | 1 1 1 0 |
| 1 1 1 1 | 100 mS     | 1 1 0 1 |
| 1 1 1 1 | 10 mS      | 1 1 0 0 |
| 1 1 1 1 | 1 mS       | 1 0 1 1 |
| 1 1 1 1 | 100 μS     | 1 0 1 0 |
| 1 1 1 1 | 10 μS      | 1 0 0 1 |
| 1 1 1 1 | 1 μS       | 1 0 0 0 |
| 1 1 1 1 | 100 nS     | 0 1 1 1 |
| 1 1 1 1 | 10 nS      | 0 1 1 0 |
| 1 1 1 1 | 1 nS       | 0 1 0 1 |
| 1 1 1 1 | 100 pS     | 0 1 0 0 |



# OPTION 22 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                           | SD<br>Part No. |
|------|---------------------------------------|----------------|
|      | Option 22 Final Assembly              | C45363         |
|      | <u>ADD</u>                            |                |
| 4    | Binary Remote Function Assembly       | C45362         |
|      | Consisting of:                        |                |
| A7   | Binary Function Select P.C. Assembly  | C39760         |
| A7   | Binary Remote Function Cable Assembly | B45361         |
| J14  | Connector, 50 Pin                     | J0170          |
| P14  | Connector, w/hood, 50 pin             | J0171          |
|      | * * * * *                             |                |
|      | Binary Function Select P.C. Assembly  | C39760         |
|      | Binary Function Select P.C. Schematic | C39757         |
| C1   | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| C2   | Capacitor, .05 $\mu$ F, 12 V          | C0672          |
| R1   | Resistor, 4.7 k, 5%, 1/4 W            | R0892          |
| U1   | Integrated Circuit, SN74145N          | 25754          |
| U2   | Integrated Circuit, SN15846N          | 19716          |
| U3   | Integrated Circuit, MC1806P           | 25733          |
| U4   | Integrated Circuit, SN15862N          | 19719          |
| U5   | Integrated Circuit, MC1808P           | 25734          |
| U6   | Integrated Circuit, SN15846N          | 19716          |
| U7   | Integrated Circuit, SN74145N          | 25754          |
| U8   | Integrated Circuit, MC857P            | 25753          |
| U9   | Integrated Circuit, MC1808P           | 25734          |
| U10  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U11  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U12  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U13  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U14  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U15  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U16  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
| U17  | Resistor Network, 4 x 5 k, 1/10 W     | 27867          |
|      | * * * * *                             |                |
|      | <u>DELETE</u>                         |                |
| A7   | Function Select P.C. Assembly         | B39803         |

OPTION 23  
REMOTE PROGRAMMING  
(Function and Resolution, Single Line, Ground True)

DESCRIPTION

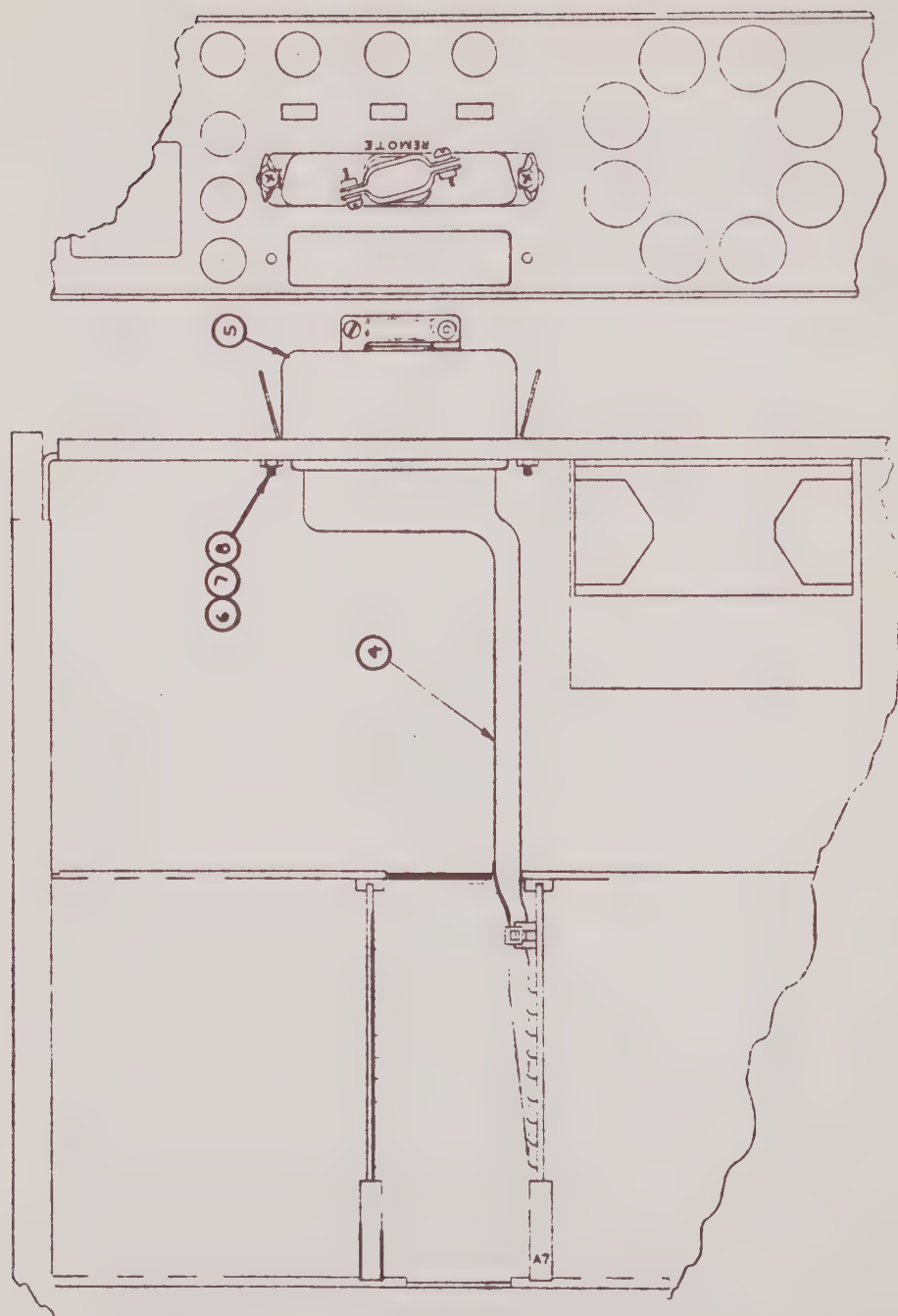
This Option provides remote control of the Function and Resolution front panel controls in a single line format. The remote control circuits use ground "1" to operate the functions. REMOTE connector J14 is a 50 pin Amphenol 57-40500.

REMOTE PIN ASSIGNMENTS

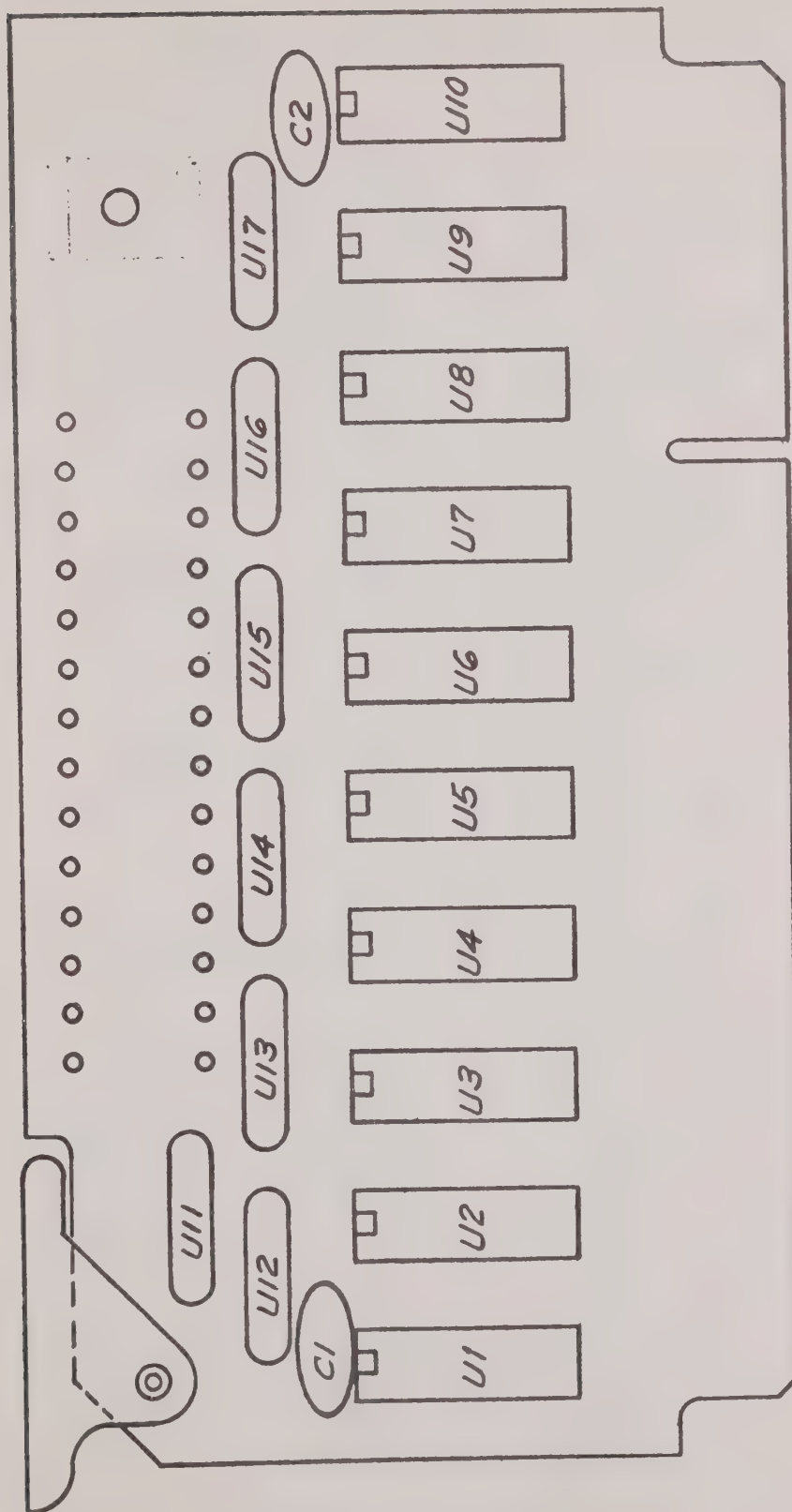
| <u>PIN</u> | <u>DESCRIPTION</u>          |
|------------|-----------------------------|
| 1          | TEST                        |
| 2          | RATIO                       |
| 3          | 10 ns                       |
| 4          | 100 ns                      |
| 5          | 1 $\mu$ s                   |
| 6          | 10 $\mu$ s                  |
| 7          | 100 $\mu$ s                 |
| 8          | 1 ms                        |
| 9          | 10 ms                       |
| 10         | 100 ms                      |
| 11         | 1 SEC                       |
| 12         | .1 Hz                       |
| 13         | FAST RECYCLE RATE           |
| 14         | TIM                         |
| 15         | RATE D                      |
| 16         | RATE A                      |
| 17         | COUNT A                     |
| 18         | HOLD                        |
| 19         | P/R x 1                     |
| 20         | P/R x 10                    |
| 21         | P/R x 10 <sup>2</sup>       |
| 22         | P/R x 10 <sup>3</sup>       |
| 23         | P/R x 10 <sup>4</sup>       |
| 24         | P/R x 10 <sup>5</sup>       |
| 40         | RESET                       |
| 48         | REMOTE FUNCTION & TIME BASE |
| 50         | BND                         |

DRAWINGS

Option 23, Final Assembly #C45368  
Option 23, A7, Single Line Function Select P.C. Assembly #B39748  
Option 23, A7, Single Line Function Select Schematic #D39745  
Option 23, Final Assembly Parts List #P/L45368



OPTION 23, FINAL ASSEMBLY #C45368





# OPTION 23 FINAL ASSEMBLY PARTS LIST

| Ref. | Description | SD<br>Part No. |
|------|-------------|----------------|
|------|-------------|----------------|

|  |                          |        |
|--|--------------------------|--------|
|  | Option 23 Final Assembly | C45368 |
|--|--------------------------|--------|

## ADD

|     |                                                        |        |
|-----|--------------------------------------------------------|--------|
| 4   | Single Line Remote Function Assembly<br>Consisting of: | C45367 |
| 4   | Single Line Function Select P.C. Assembly              | B39748 |
| 5   | Single Line Remote Function Cable Assembly             | B45366 |
| P14 | Connector, w/hood, 50 pin                              | J0171  |

\* \* \* \* \*

|    |                                            |        |
|----|--------------------------------------------|--------|
| A7 | Single Line Function Select P.C. Assembly  | B39748 |
| A7 | Single Line Function Select P.C. Schematic | D39745 |

|    |                              |       |
|----|------------------------------|-------|
| C1 | Capacitor, .05 $\mu$ F, 12 V | C0672 |
| C2 | Capacitor, .05 $\mu$ F, 12 V | C0672 |

|    |                             |       |
|----|-----------------------------|-------|
| U1 | Integrated Circuit, MC1808P | 25734 |
| U2 | Integrated Circuit, MC857P  | 25753 |
| U3 | Integrated Circuit, MC1808P | 25734 |
| U4 | Integrated Circuit, MC836P  | 25704 |
| U5 | Integrated Circuit, MC1808P | 25734 |

|     |                              |       |
|-----|------------------------------|-------|
| U6  | Integrated Circuit, SN15862N | 19719 |
| U7  | Integrated Circuit, MC1808P  | 25734 |
| U8  | Integrated Circuit, MC1808P  | 25734 |
| U9  | Integrated Circuit, MC1808P  | 25734 |
| U10 | Integrated Circuit, MC1808P  | 25734 |

|     |                                   |       |
|-----|-----------------------------------|-------|
| U11 | Resistor Network, 4 x 5 k, 1/10 W | 27867 |
| U12 | Resistor Network, 4 x 5 k, 1/10 W | 27867 |
| U13 | Resistor Network, 4 x 5 k, 1/10 W | 27867 |
| U14 | Resistor Network, 4 x 5 k, 1/10 W | 27867 |
| U15 | Resistor Network, 4 x 5 k, 1/10 W | 27867 |

|     |                                   |       |
|-----|-----------------------------------|-------|
| U16 | Resistor Network, 4 x 5 k, 1/10 W | 27867 |
| U17 | Resistor Network, 4 x 5 k, 1/10 W | 27867 |

\* \* \* \* \*

|  |                                            |        |
|--|--------------------------------------------|--------|
|  | Single Line Remote Function Cable Assembly | B45366 |
|--|--------------------------------------------|--------|

|     |                   |       |
|-----|-------------------|-------|
| J14 | Connector, 50 pin | J0170 |
|-----|-------------------|-------|

## DELETE

|     |                               |         |
|-----|-------------------------------|---------|
| A7  | Function Select P.C. Assembly | B39803  |
| X14 | Cover Plate, 50 pin connector | 39443-2 |





OPTION 26  
ANALOG TRIGGER LEVEL CONTROL  
(used with Option 20 or 21)

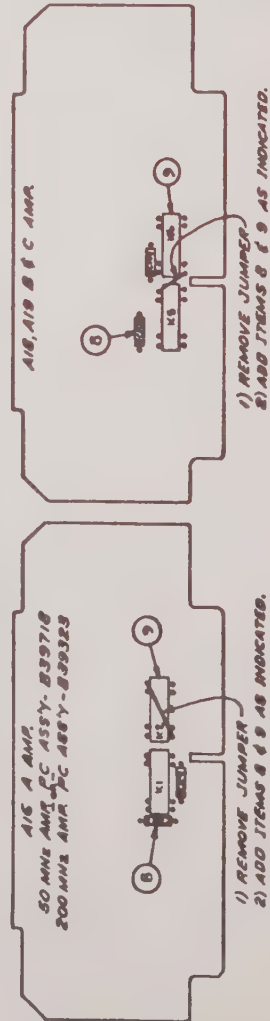
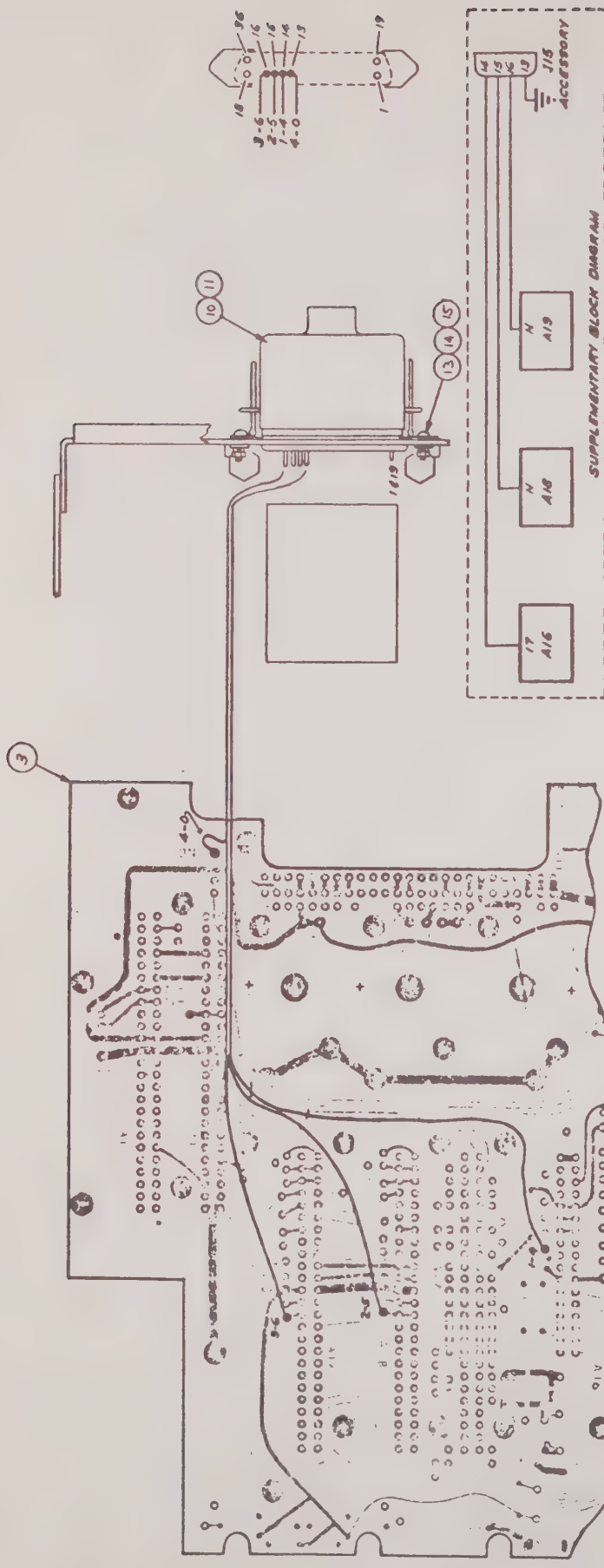
This option provides remote control of the A, B, and C INPUT trigger LEVEL controls by means of analog levels applied to the J15 ACCESSORY connector. This option is used in conjunction with Remote Control Options 20 or 21. The analog levels for each input and the pin assignments are listed below: J15 = AMPEHNOL 57-40360

| <u>PIN</u> | <u>FUNCTION</u>                |
|------------|--------------------------------|
| 14         | +1 V for A INPUT trigger LEVEL |
| 15         | +3 V for B INPUT trigger LEVEL |
| 16         | +3 V for C INPUT trigger LEVEL |
| 13         | GND                            |

The drawings for this option are the following:

Option 26, Final Assembly #C45318

Option 26, Final Assembly Parts List #P/L45318



OPTION 26, FINAL ASSEMBLY C45318

# OPTION 26 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                                          | SD<br>Part No.   |
|------|------------------------------------------------------|------------------|
| 3    | Option 26 Final Assembly<br>See Mother P.C. Assembly | C45318<br>C39114 |
|      | <u>ADD</u>                                           |                  |
| 8    | Diode, 1N4151                                        | C40150           |
| 9    | Relay                                                | K0133            |
| J15  | Connector, w/bales 36 pin                            | J0292            |
| P15  | Connector, w/hood, 36 pin                            | J0172            |

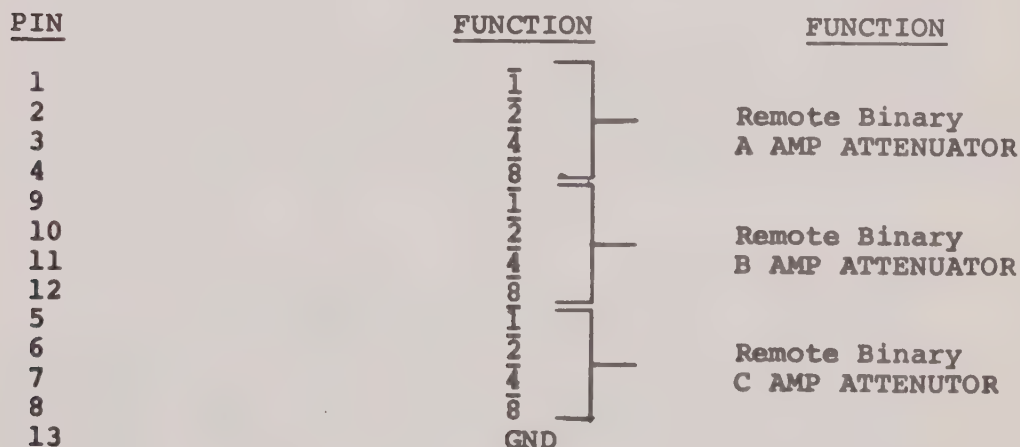


OPTION 27  
DIGITAL TRIGGER LEVEL CONTROL  
(used with Option 20)

DESCRIPTION

This option allows rear panel digital operation of the A, B, and C INPUT Trigger Level controls. Option 20 REMOTE PROGRAMMING is included in this option and an A17 printed circuit board is added with twelve ATTENUATOR control lines accessible on rear panel connector J15, Amphenol type 36 pin 57-40360.

TRIGGER LEVEL CONTROL PIN ASSIGNMENTS



LEVEL CODING FOR PINS

NOMINAL TRIGGER LEVEL X ATTEN FACTOR

| <u>STATE</u> | <u>CODE</u> |   |   |   | <u>TRIGGER LEVEL</u> |        |
|--------------|-------------|---|---|---|----------------------|--------|
|              | 1           | 2 | 4 | 8 | A                    | B&C    |
| 0            | +           | + | + | + | +0.9996              | +2.996 |
| 1            | 0           | + | + | + | +0.8568              | +2.568 |
| 2            | +           | 0 | + | + | +0.7140              | +2.140 |
| 3            | 0           | 0 | + | + | +0.5712              | +1.712 |
| 4            | +           | + | 0 | + | +0.4284              | +1.284 |
| 5            | 0           | + | 0 | + | +0.2856              | +0.856 |
| 6            | +           | 0 | 0 | + | +0.1428              | +0.428 |



|    |   |   |   |   |         |        |
|----|---|---|---|---|---------|--------|
| 7  | 0 | 0 | 0 | + | 0.0000  | 0.000  |
| 8  | + | + | + | 0 | -0.1428 | -0.428 |
| 9  | 0 | + | + | 0 | -0.2856 | -0.856 |
| 10 | + | 0 | + | 0 | -0.4284 | -1.284 |
| 11 | 0 | 0 | + | 0 | -0.5712 | -1.172 |
| 12 | + | + | 0 | 0 | -0.7140 | -2.140 |
| 13 | 0 | + | 0 | 0 | -0.8568 | -2.568 |
| 14 | + | 0 | 0 | 0 | -0.9996 | -2.996 |
| 15 | 0 | 0 | 0 | 0 | -1.1424 | -3.424 |

+ = +2.5V tp +5.0V, OR OPEN CIRCUIT

0 = 0.0V to +0.5V, OR SWITCH TO GND OR SATURATED NPN

#### DRAWINGS

Option 27, Final Assembly #C45387

Option 27, Cable Assembly #B45386

Option 27, Final Assembly Parts List #P/L45387

Option 27, Trigger Level Binary Control P.C. Assembly #B39259

Option 27, Trigger Level Binary Control Schematic #D39256

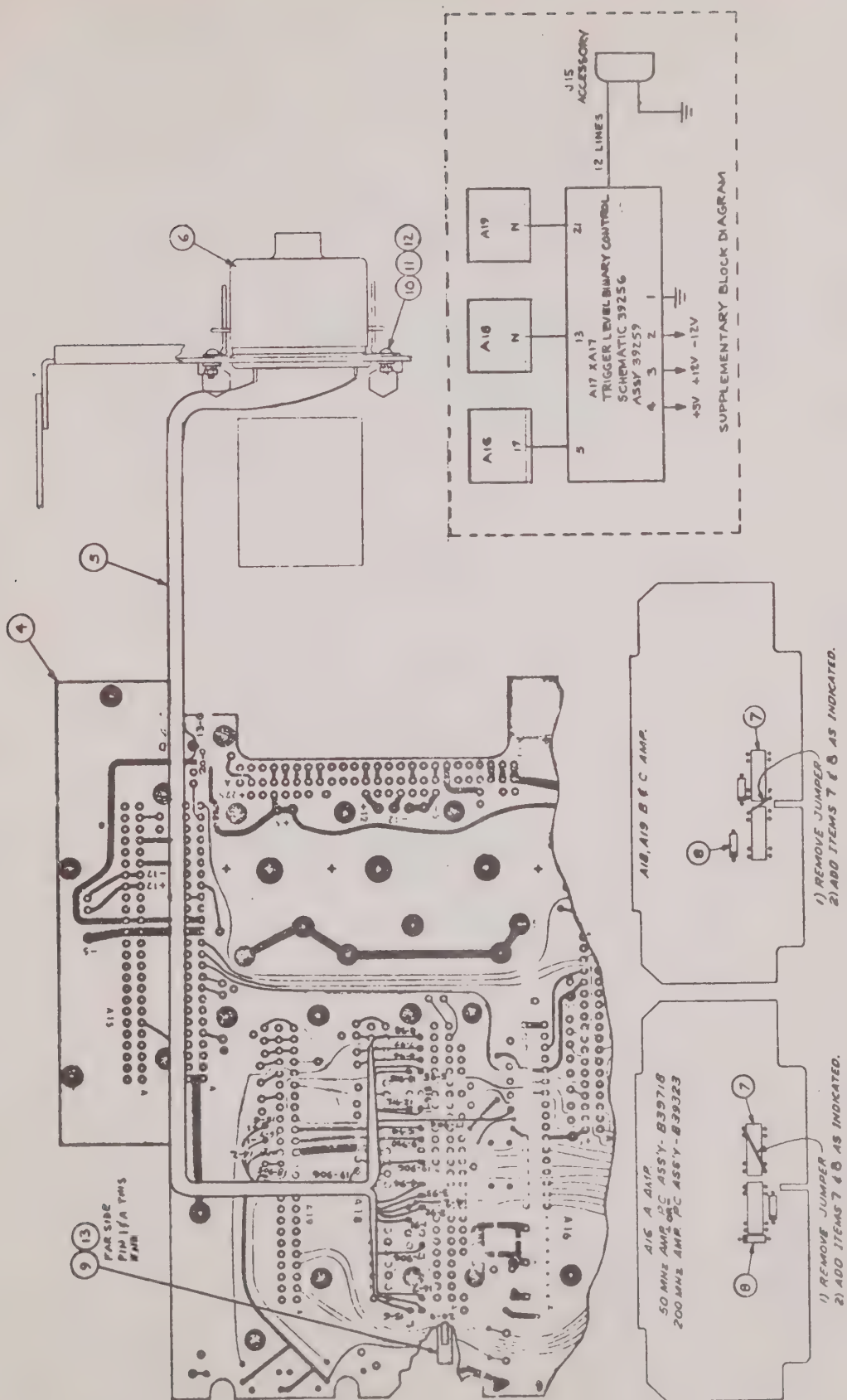
Option 27, Trigger Level Binary Control Parts List #P/L39259

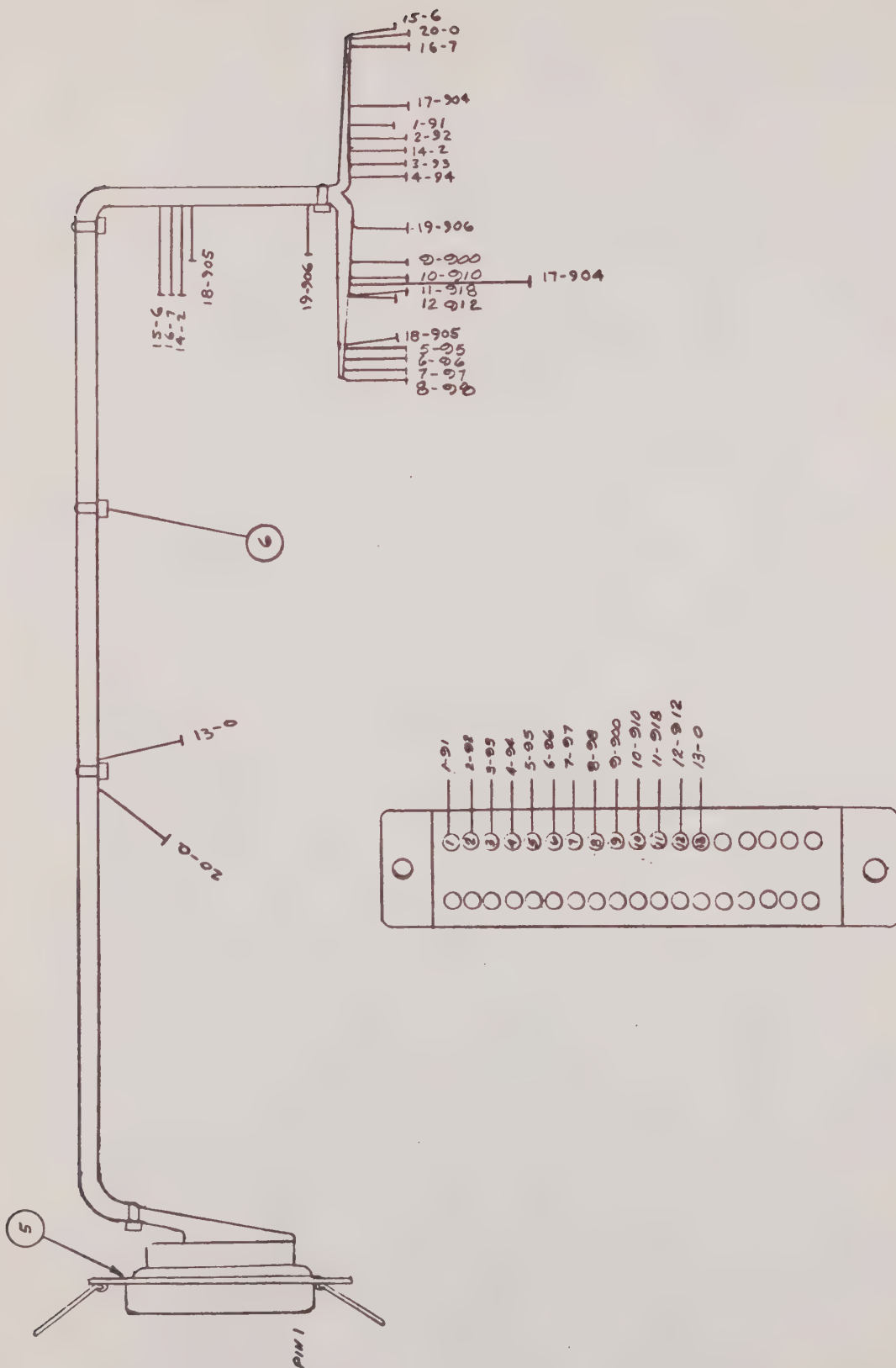
#### CALIBRATION PROCEDURE - A AMP

- 1) Set BCD to STATE 7 (low on pins 1,2,3 and high on pin 4 of J15).
- 2) Measure voltage at pin E on P.C. connector XA17 with DVM.
- 3) Adjust A AMP ZERO, A17R5, for 0.0000 V dc.
- 4) Set BCD to STATE 0 (high on pins 1,2,3, and 4 of J15).
- 5) Adjust A AMP F.S., A17R8, for +0.9996 V dc.
- 6) Repeat steps 1) through 5).
- 7) Accuracy should be better than 3%.

#### CALIBRATION PROCEDURE - B OR C AMP

- 1) Set BCD to STATE 7 (low on pins 9,10, & 11 and high on pin 12 for B AMP or low on pins 5,6, & 7 and high on pin 8 for C AMP).
- 2) Measure voltage at pin P (B AMP) or Y (C AMP) on P.C. connector XA17 with DVM.
- 3) Adjust B AMP ZERO, A17R14, or C AMP ZERO, A17R23 for 0.0000 V dc.
- 4) Set BCD to STATE 0 (high on pins 9,10,11, and 12 for B AMP and high on pins 5,6,7, and 8 for C AMP on J15).
- 5) Adjust B AMP F.S., A17R17, or C AMP F.S., A17R26, for +2.996 V dc.
- 6) Repeat steps 1) through 5).
- 7) Accuracy should be better than 3%.

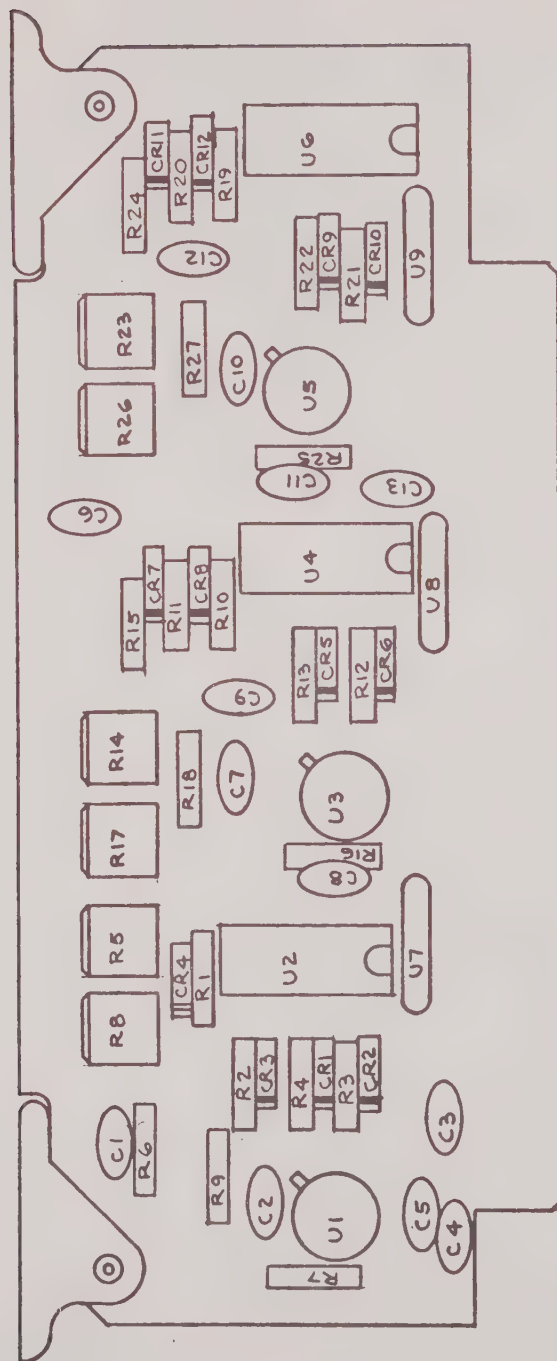




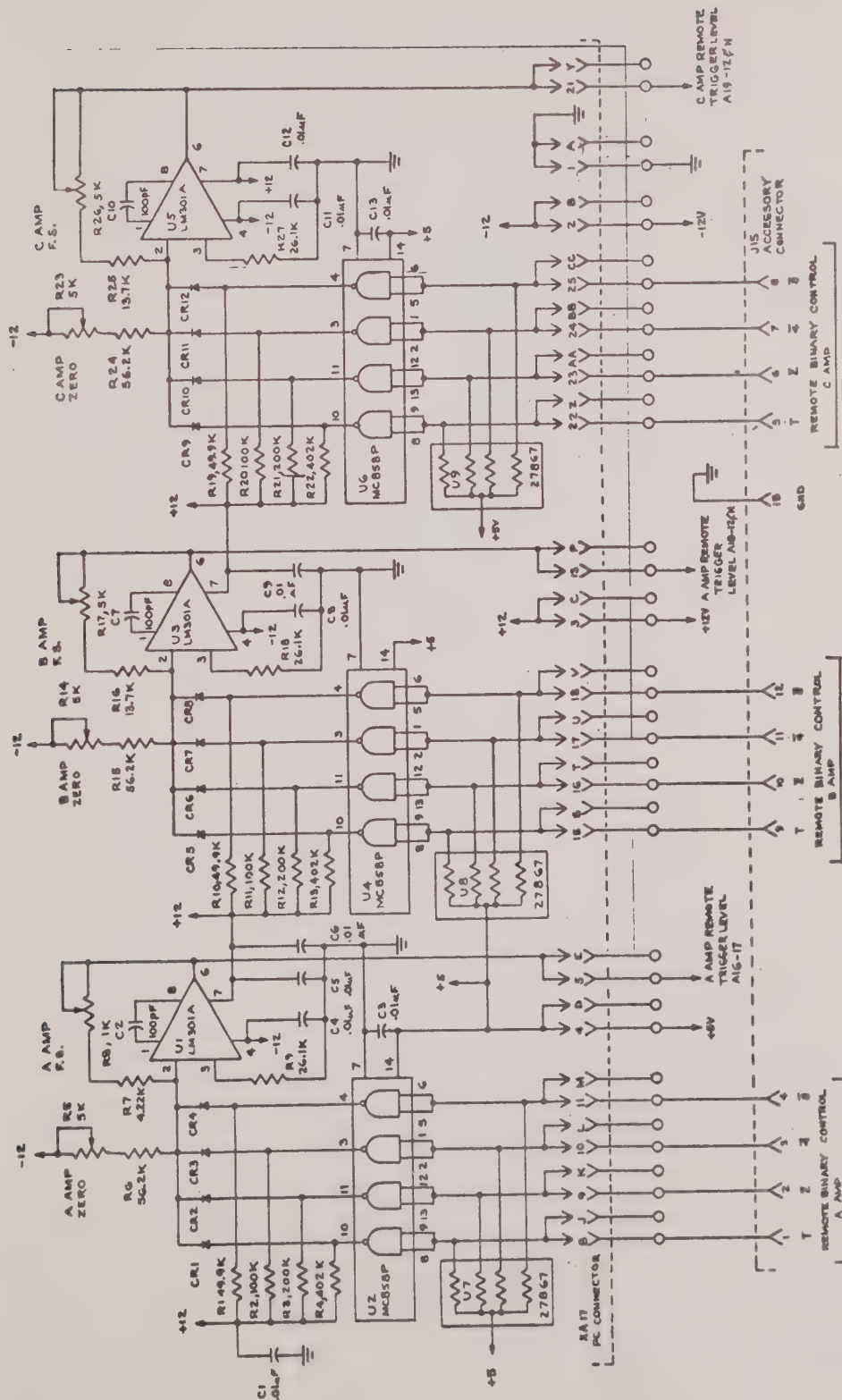
OPTION 27, CABLE ASSEMBLY #B45386

# OPTION 27 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                                    | SD<br>Part No. |
|------|------------------------------------------------|----------------|
|      | Option 27 Final Assembly                       | C45387         |
|      | <u>ADD</u>                                     |                |
| 4    | See Option 20 Final Assembly                   | C45356         |
| 5    | Option 27 Cable Assembly                       | B45386         |
| A17  | See Trigger Level Binary Control P.C. Assembly | B39259         |
| P15  | Connector, 2/hood, 36 pin                      | J0172          |
| 7    | Relay                                          | K0133          |
| 8    | Diode, 1N4151                                  | CR0150         |
| XA14 | Connector, 50 pin, P.C.                        |                |
|      | * * * * *                                      |                |
|      | Option 27 Cable Assembly                       | 45386          |
| J15  | Connector, 36 pin                              | J0292          |
|      | <u>DELETE</u>                                  |                |
| 19   | Cover Plate, 36 pin                            | 39621          |



OPTION 27, TRIGGER LEVEL BINARY CONTROL P.C. ASSEMBLY #B39259



OPTION 27, TRIGGER LEVEL BINARY CONTROL SCHEMATIC #D39256



# A17 TRIGGER LEVEL BINARY CONTROL P.C. ASSEMBLY PARTS LIST

| Ref. | Description                                 | SD<br>Part No. |
|------|---------------------------------------------|----------------|
| A17  | Trigger Level Binary Control P.C. Assembly  | B39259         |
|      | Trigger Level Binary Control P.C. Schematic | D39256         |
| C1   | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C2   | Capacitor, 100 pF, DM15                     | C0536          |
| C3   | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C4   | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C5   | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C6   | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C7   | Capacitor, 100 pF, DM15                     | C0536          |
| C8   | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C9   | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C10  | Capacitor, 100 pF, DM15                     | C0536          |
| C11  | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C12  | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| C13  | Capacitor, .01 $\mu$ F, 150 V, disc         | C0233          |
| CR1  | Diode, 1N4151                               | CR0150         |
| CR2  | Diode, 1N4151                               | CR0150         |
| CR3  | Diode, 1N4151                               | CR0150         |
| CR4  | Diode, 1N4151                               | CR0150         |
| CR5  | Diode, 1N4151                               | CR0150         |
| CR6  | Diode, 1N4151                               | CR0150         |
| CR7  | Diode, 1N4151                               | CR0150         |
| CR8  | Diode, 1N4151                               | CR0150         |
| CR9  | Diode, 1N4151                               | CR0150         |
| CR10 | Diode, 1N4151                               | CR0150         |
| CR11 | Diode, 1N4151                               | CR0150         |
| CR12 | Diode, 1N4151                               | CR0150         |
| R1   | Resistor, 49.9 k, 1%, 1/8 W, MF             | R2642          |
| R2   | Resistor, 100 k, 1%, 1/8 W, MF              | R2638          |
| R3   | Resistor, 200 k, 1%, 1/8 W, MF              | R2643          |
| R4   | Resistor, 402 k, 1%, 1/8 W, MF              | R2798          |
| R5   | Resistor, 5 k, potentiometer                | R2801          |
| R6   | Resistor, 56.2 k, 1%, 1/8 W, MF             | R2799          |
| R7   | Resistor, 4.22 k, 1%, 1/8 W, MF             | R2800          |
| R8   | Resistor, 1 k, potentiometer                | R2734          |
| R9   | Resistor, 26.7 k, 1%, 1/8 W, MF             | R2762          |
| R10  | Resistor, 49.9 k, 1%, 1/8 W, MF             | R2642          |
| R11  | Resistor, 100 k, 1%, 1/8 W, MF              | R2638          |
| R12  | Resistor, 200 k, 1%, 1/8 W, MF              | R2643          |

## A17 TRIGGER LEVEL BINARY CONTROL P.C. ASSEMBLY PARTS LIST (Cont'd)

| Ref. | Description                     | SD<br>Part No. |
|------|---------------------------------|----------------|
| R13  | Resistor, 402 k, 1%, 1/8 W, MF  | R2798          |
| R14  | Resistor, 5 k, potentiometer    | R2801          |
| R15  | Resistor, 56.2 k, 1%, 1/8 W, MF | R2799          |
| R16  | Resistor, 13.7 k, 1%, 1/8 W, MF | R2802          |
| R17  | Resistor, 5 k, potentiometer    | R2801          |
| R18  | Resistor, 26.7 k, 1%, 1/8 W, MF | R2762          |
| R19  | Resistor, 49.9 k, 1%, 1/8 W, MF | R2642          |
| R20  | Resistor, 100 k, 1%, 1/8 W, MF  | R2638          |
| R21  | Resistor, 200 k, 1%, 1/8 W, MF  | R2643          |
| R22  | Resistor, 402 k, 1%, 1/8 W, MF  | R2798          |
| R23  | Resistor, 5 k, potentiometer    | R2801          |
| R24  | Resistor, 56.2 k, 1%, 1/8 W, MF | R2799          |
| R25  | Resistor, 13.7 k, 1%, 1/8 W, MF | R2802          |
| R26  | Resistor, 5 k, potentiometer    | R2801          |
| R27  | Resistor, 26.7 k, 1%, 1/8 W, MF | R2762          |
| U1   | Integrated Circuit, LM301A      | 25745          |
| U2   | Integrated Circuit, MC858P      | 25748          |
| U3   | Integrated Circuit, LM301A      | 25745          |
| U4   | Integrated Circuit, MC858P      | 25748          |
| U5   | Integrated Circuit, LM301A      | 25745          |
| U6   | Integrated Circuit, MC858P      | 25748          |
| U7   | Resistor Network, 5 k           | 27867          |
| U8   | Resistor Network, 5 k           | 27867          |
| U9   | Resistor Network, 5 k           | 27867          |



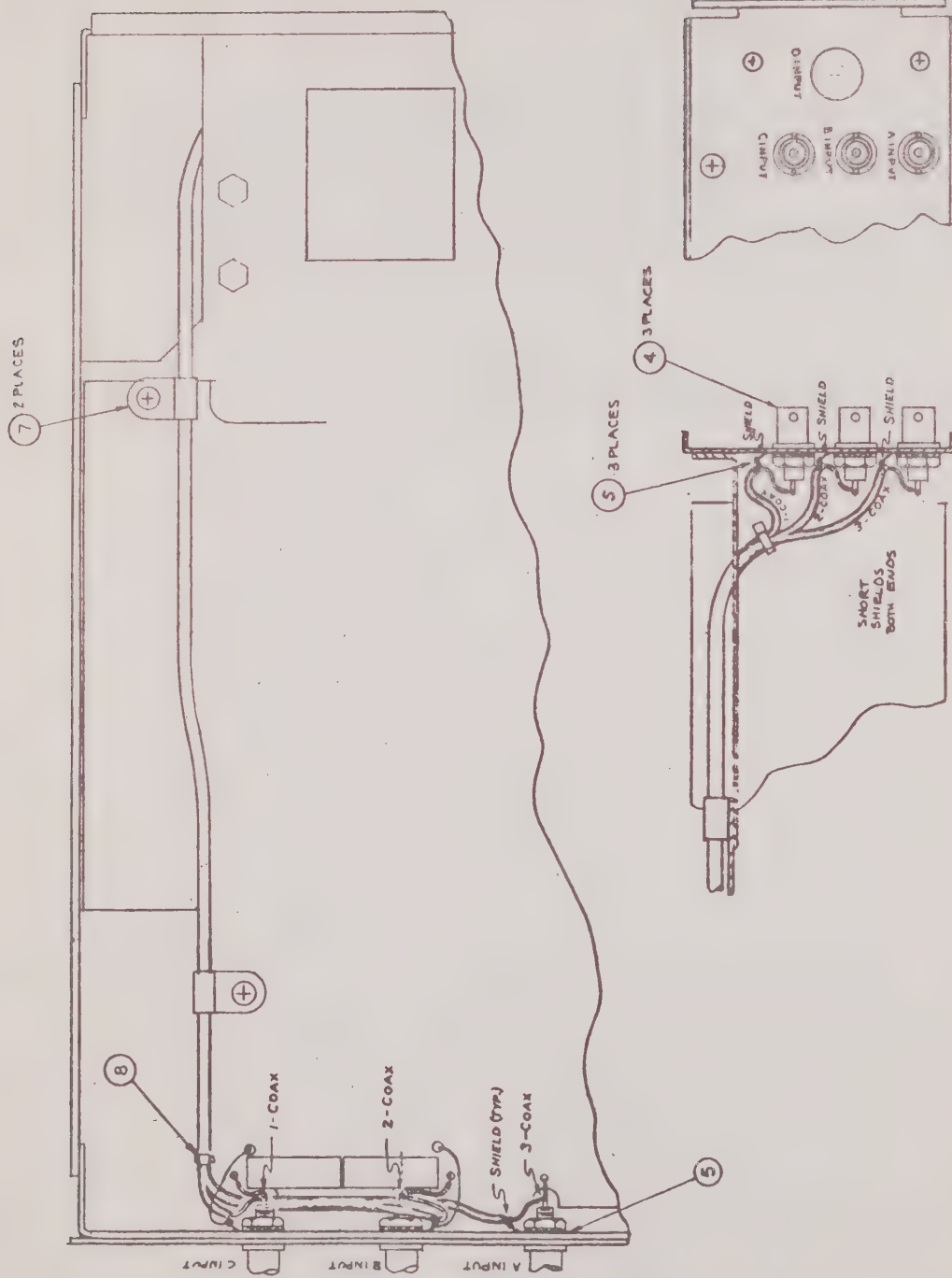
OPTION 32  
REAR SIGNAL INPUTS

DESCRIPTION

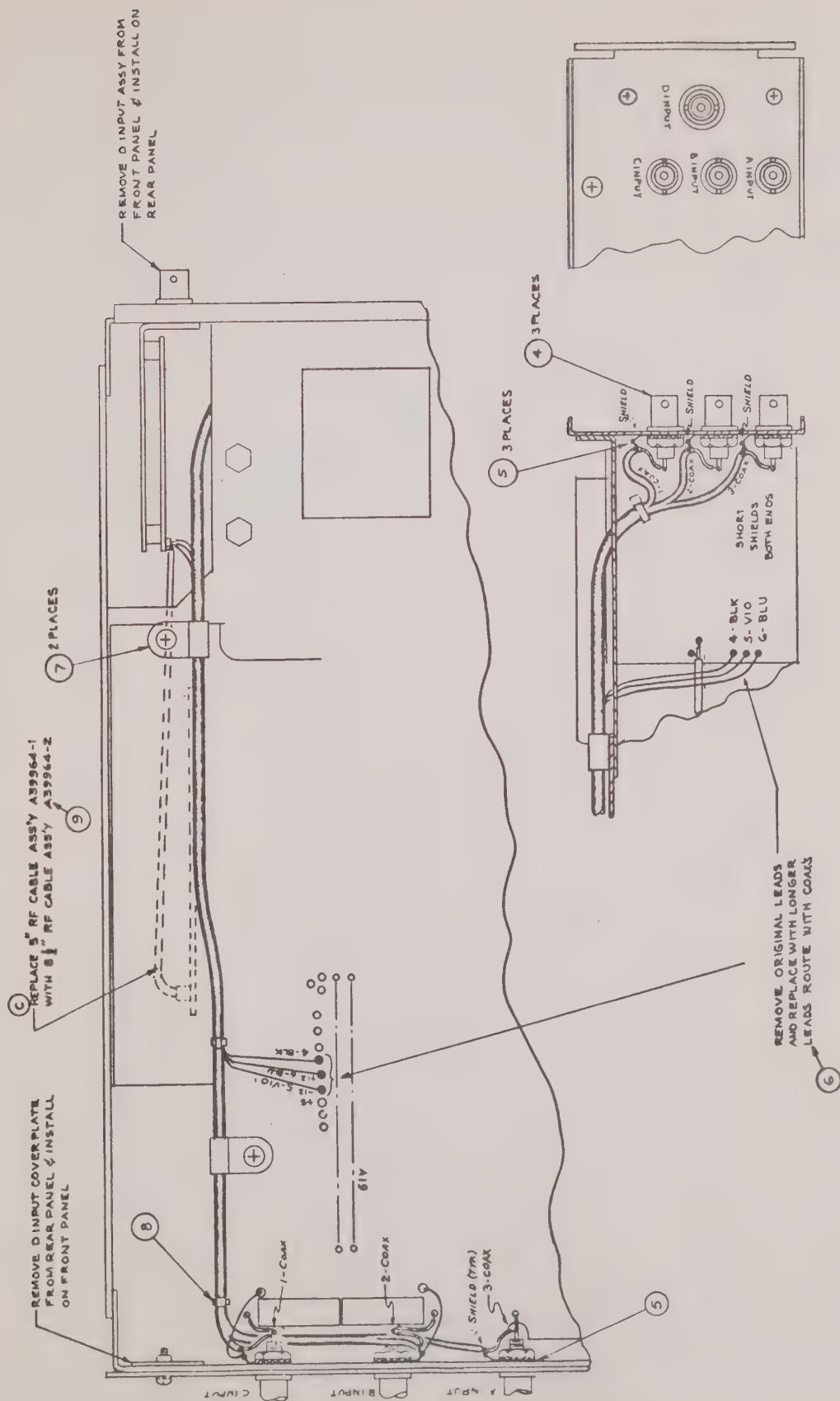
This option places the standard front panel only A, B, C, and D inputs on the rear panel of the instrument. The added A, B, and C rear panel connectors are parallel wired to the corresponding front panel A, B, and C signal inputs. In addition, Models 6152 and 6153 also switch the D INPUT assembly to the rear panel and place the rear panel D INPUT cover plate on the front panel.

DRAWINGS:

Option 32, Final Assembly Models 6150 and 6151 #C45395  
Option 32, Final Assembly Model 6152 #C45396  
Option 32, Final Assembly Model 6153 #C45397



OPTION 32, FINAL ASSEMBLY MODELS 6150 and 6151 #C45395







# OPTION 32 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                                 | SD<br>Part No. |
|------|---------------------------------------------|----------------|
| 1    | Option 32 Final Assembly Models 6150 & 6151 | C45395         |
| 1    | Option 32 Final Assembly Model 6152         | C45396         |
| 1    | Option 32 Final Assembly Model 6153         | C45397         |
|      | <u>ADD</u>                                  |                |
| 4    | Connector, BNC                              | J0165          |
|      | <u>DELETE</u>                               |                |
| 13   | Snap Button                                 | H1667          |



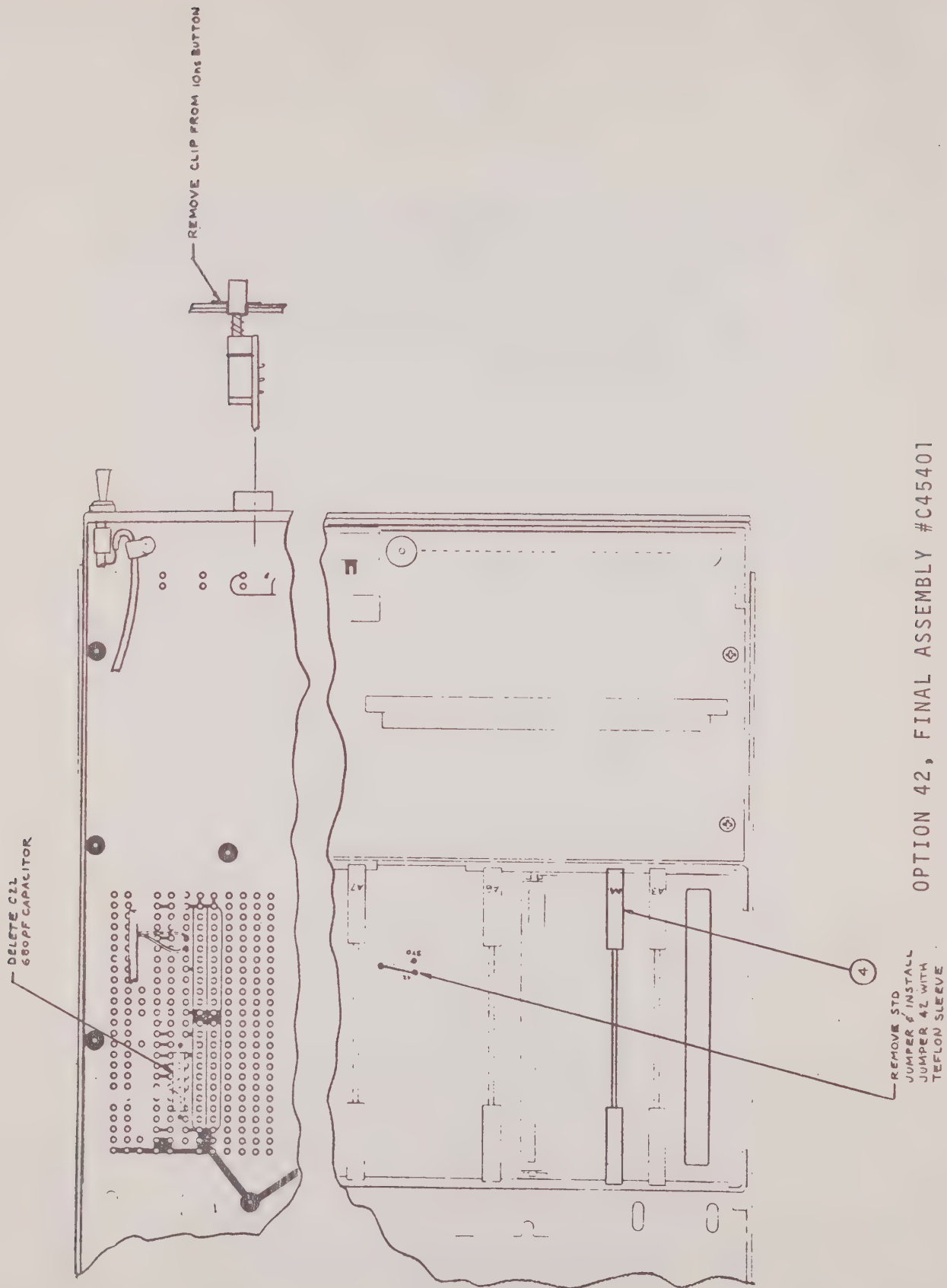
OPTION 42  
10 ns TIM AND PERIOD RESOLUTION

DESCRIPTION

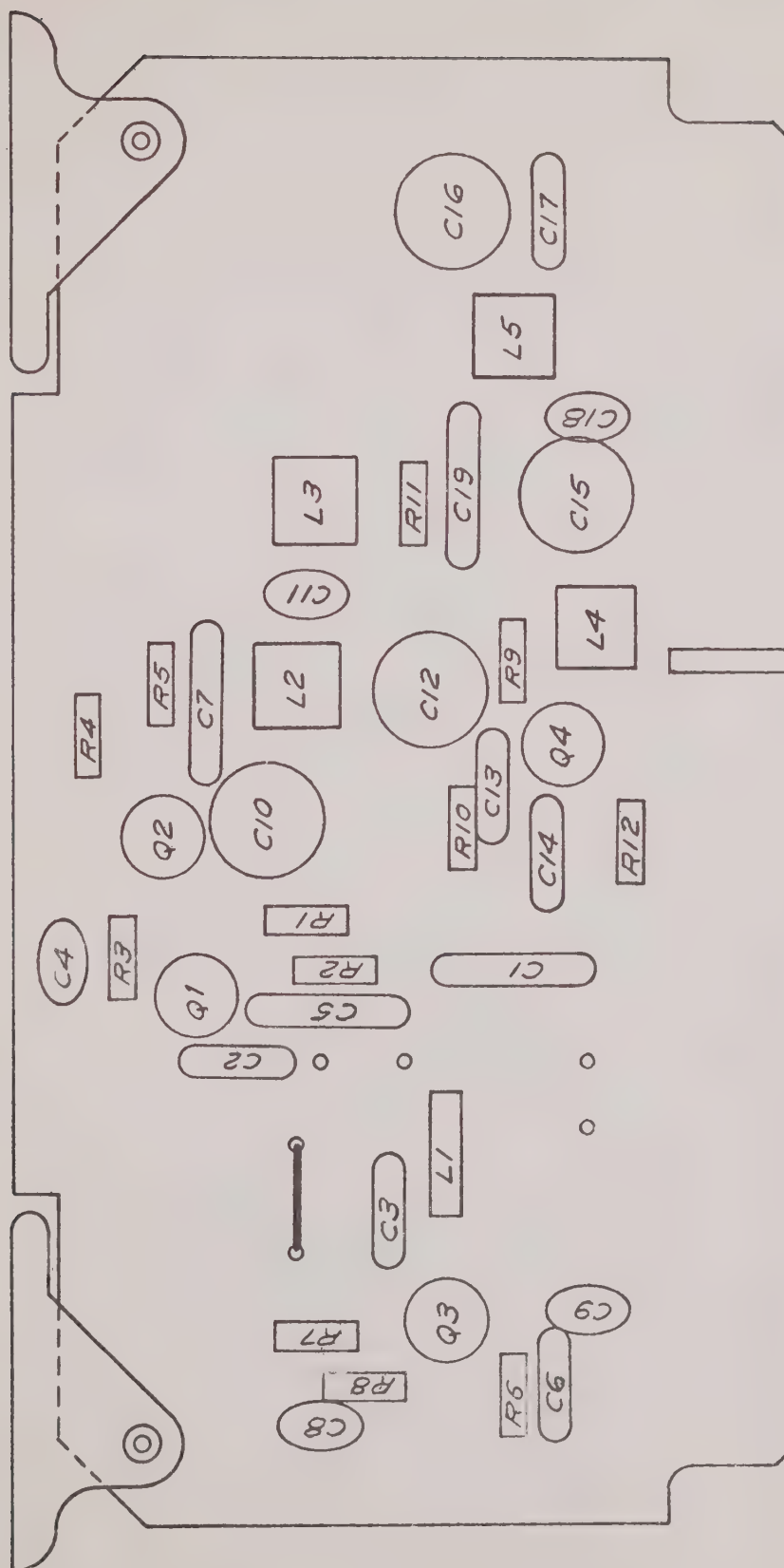
This option provides 10 ns TIM and 10 ns PERIOD resolutions with the following modifications to the standard Model 6150 series units. On the Mother Board the jumper wire to the STD pin is removed and attached with a Teflon sleeve to the 42 pin. Also, remove capacitor C22 from the Mother Board and the clip from the 10 ns front panel pushbutton. A4, 100 MHz MULTIPLIER assembly is inserted into the XA4 connector providing the necessary increased time base frequency.

DRAWINGS

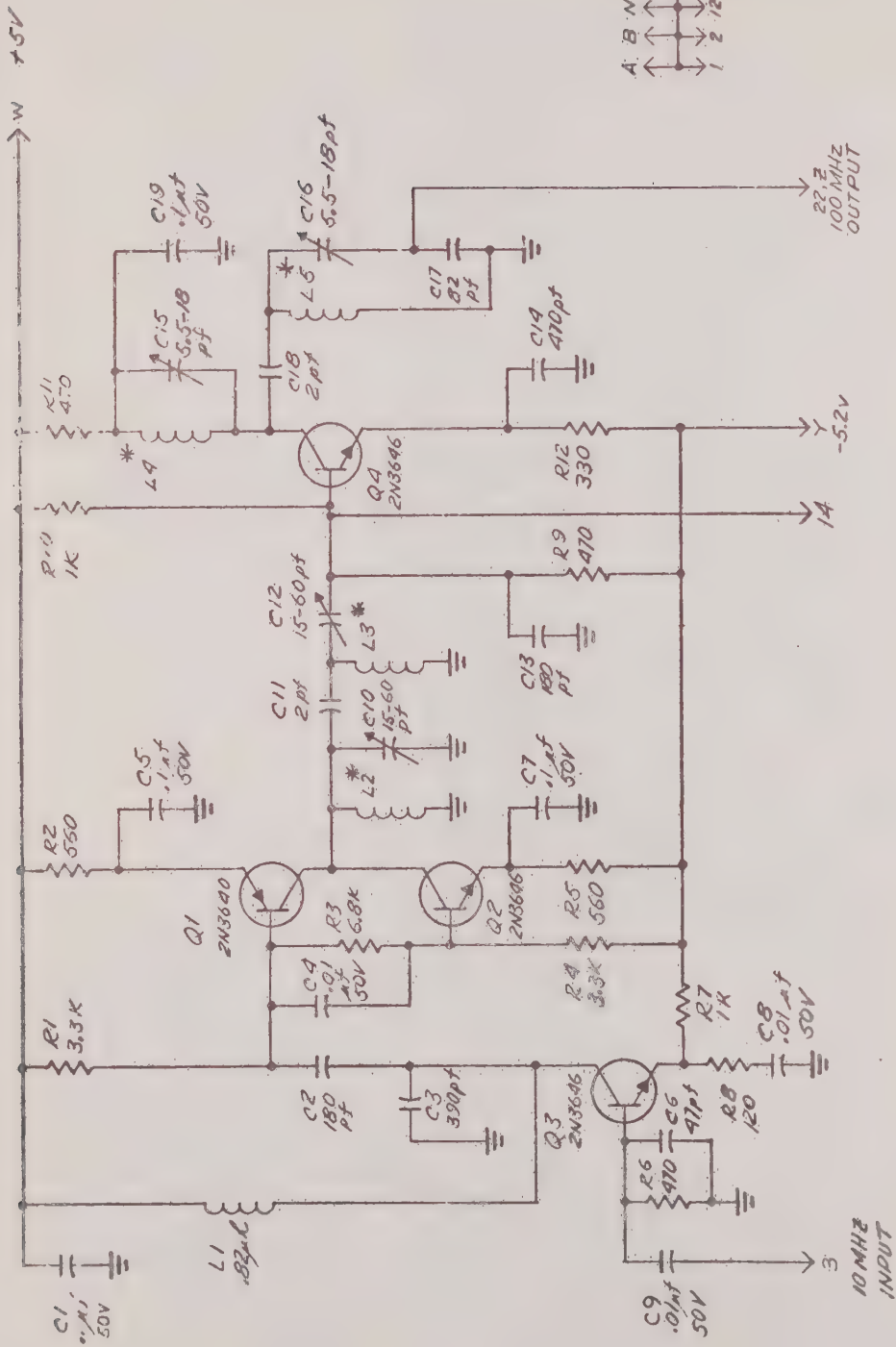
Option 42, Final Assembly #C45401  
Option 42, A4, 100 MHz Multiplier P.C. Assembly #B39363  
Option 42, A4, 100 MHz Multiplier Schematic #C39360  
Option 42, Final Assembly #P/L45401



OPTION 42, FINAL ASSEMBLY #C45401

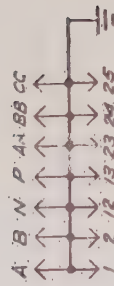






NOTE: UNLESS OTHERWISE NOTED

- 1) RESISTORS:  $\frac{1}{4}$  W, 5%.
- 2) \* INDUCTORS: 2.13 & 4.25 ARE CUSTOM



OPTION 42, A4, 100 MHz MULTIPLIER SCHEMATIC #C29430

# 100 MHz MULTIPLIER P.C. ASSEMBLY

| REF. | DESCRIPTION                                   | SD<br>PART NO. |
|------|-----------------------------------------------|----------------|
|      | 100 MHz Multiplier P.C. Assembly              | B39363         |
|      | 100 MHz Multiplier P.C. Assembly<br>Schematic | C39360         |
| C1   | Capacitor, .1 $\mu$ F, 50 V                   | C0881          |
| C2   | Capacitor, 180 pF, 500 V                      | C0707          |
| C3   | Capacitor, 390 pF, 500 V                      | C0541          |
| C4   | Capacitor, .01 $\mu$ F, 50 V                  | C0562          |
| C5   | Capacitor, .1 $\mu$ F, 50 V                   | C0881          |
| C6   | Capacitor, 47 pF, 500 V                       | C0533          |
| C7   | Capacitor, .1 $\mu$ F, 50 V                   | C0881          |
| C8   | Capacitor, .01 $\mu$ F, 50 V                  | C0562          |
| C9   | Capacitor, .01 $\mu$ F, 50 V                  | C0562          |
| C10  | Capacitor, 15-60 pF                           | C1132          |
| C11  | Capacitor, 2 pF, 500 V                        | C0261          |
| C12  | Capacitor, 15-60 pF                           | C1132          |
| C13  | Capacitor, 180 pF, 500 V                      | C0707          |
| C14  | Capacitor, 470 pF, 300 V                      | C0542          |
| C15  | Capacitor, 5.5-18 pF                          | C0712          |
| C16  | Capacitor, 5.5-18 pF                          | C0712          |
| C17  | Capacitor, 82 pF, 500 V                       | C0535          |
| C18  | Capacitor, 2 pF, 500 V                        | C0261          |
| C19  | Capacitor, .1 $\mu$ F, 50 V                   | C0881          |
| L1   | Inductor, .82 $\mu$ h                         | L0059          |
| L2   | Inductor, .82 $\mu$ h                         | B39744-1       |
| L3   | Inductor, .82 $\mu$ h                         | B39744-1       |
| L4   | Inductor, .82 $\mu$ h                         | B39744-2       |
| L5   | Inductor, .82 $\mu$ h                         | B39744-2       |
| Q1   | Transistor, 2N3640                            | Q0178          |
| Q2   | Transistor, 2N3646                            | Q0218          |
| Q3   | Transistor, 2N3646                            | Q0218          |
| Q4   | Transistor, 2N3646                            | Q0218          |
| R1   | Resistor, 3.3 K, 1/4 W, 5%                    | R0742          |
| R2   | Resistor, 560 $\Omega$ , 1/4 W, 5%            | R0819          |
| R3   | Resistor, 6.8 K, 1/4 W, 5%                    | R0696          |
| R4   | Resistor, 3.3 K, 1/4 W, 5%                    | R0742          |
| R5   | Resistor, 560 $\Omega$ , 1/4 W, 5%            | R0819          |

# 100 MHz MULTIPLIER P.C. ASSEMBLY (CON'D)

| REF. | DESCRIPTION                        | SD<br>PART NO. |
|------|------------------------------------|----------------|
| R6   | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R7   | Resistor, 1 K, 1/4 W, 5%           | R0765          |
| R8   | Resistor, 120 $\Omega$ , 1/4 W, 5% | R1461          |
| R9   | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R10  | Resistor, 1 K, 1/4 W, 5%           | R0765          |
| R11  | Resistor, 470 $\Omega$ , 1/4 W, 5% | R1044          |
| R12  | Resistor, 330 $\Omega$ , 1/4 W, 5% | R0662          |
|      | Extractor                          | H1743          |
|      | Roll Pin                           | H1083          |
|      | Extractor, Hot Stamp, A4           | A39842-4       |

\*\*\*\*\*

## OPTION 42 FINAL ASSEMBLY PARTS LIST

| Ref. | Description                          | SD<br>Part No. |
|------|--------------------------------------|----------------|
| 1    | Option 42 Final Assembly             | C45401         |
|      | <u>ADD</u>                           |                |
| A4   | See 100 MHz Multiplier P.C. Assembly | B39363         |
|      | <u>DELETE</u>                        |                |
| C22  | Capacitor, 680 pF                    | C0736          |
| 10   | Switch Stop Bracket                  | 39933          |







